The Welding Engineer

Edited by L. B. Mackenzie

$3.00 per year in U. S. | Reg. U. S. Pat. Office | $4.00 per year abroad

Vol. 8 | 608 S. Dearborn St. | APRIL 1923 | Chicago, Ill. | No. 4

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ANYTHING AND EVERYTHING
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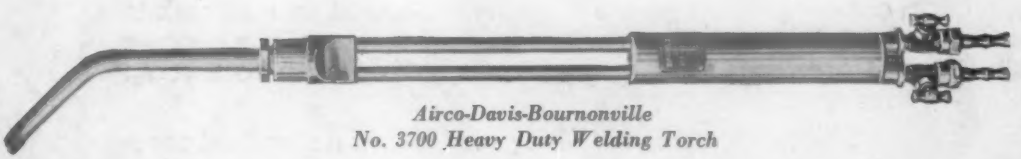

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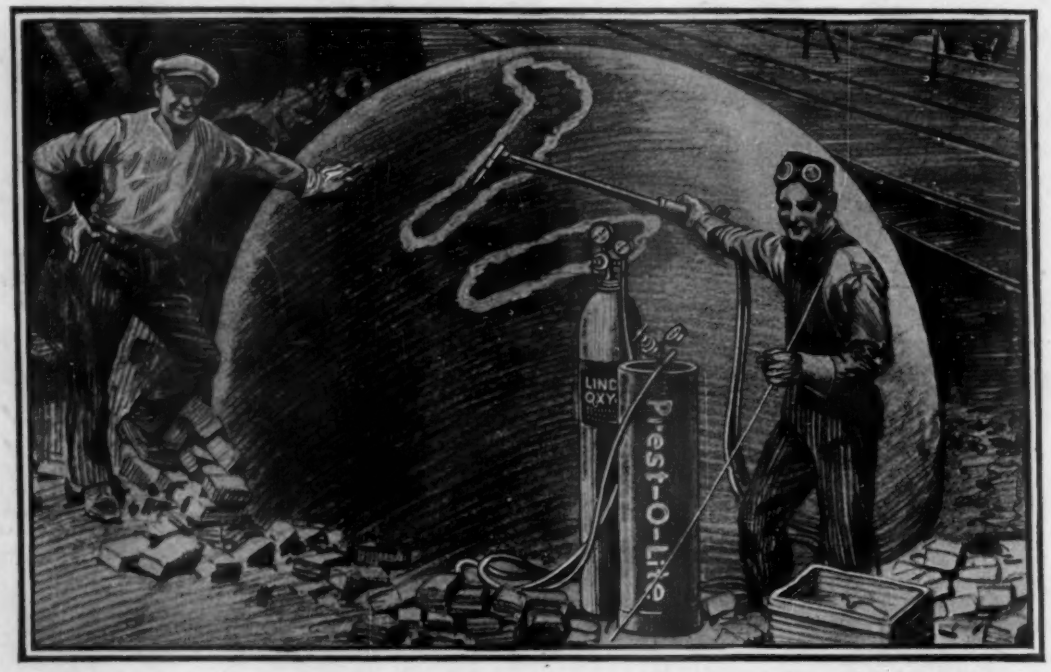

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And with good reason. A few years ago monster cast-iron pots like these were regarded as "unweldable". In out-of-the-way places they were allowed to accumulate and encumber the smelter yards, because of the expense of breaking them up and transporting them to a scrap market.

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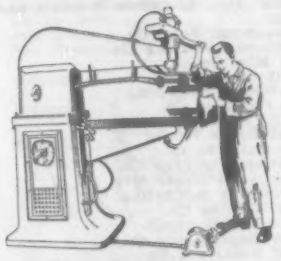

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CONNECTICUT
Hartford.....412 Trumbull St.

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Washington .....Maryland Ave. and 9th St., S. W.

FLORIDA
Jacksonville, 13 Cedar St., P. O. Box 124
Tampa.....1702 Grand Central Ave.

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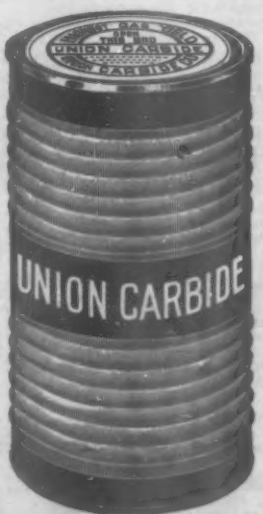
Atlanta.....Haynes and Rhodes Sts. P. O. Box 1594
Savannah, Ogeechee Canal and Broughton St. P. O. Box 78.

ILLINOIS
Chicago.....132 So. Michigan Boulevard
Danville.....511 Oak St.
Decatur.....133 W. William St.
East St. Louis.....700 Broadway
Marion..315 S. Granite St., P. O. Box 747
Monmouth.....61½ Public Square
Peoria.....100-110 Edmund St.
Quincy.....313 Delaware St.
Springfield.....1301 Washington St.
Streator.....501 E. Hickory St



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Evansville.....1401 Illinois St.
Fort Wayne.....2206 Broadway
Indianapolis.....601-637 Kentucky Ave.
Terre Haute.....714 N. Fifth St.

IOWA
Davenport.....118 Harrison St.
Des Moines.....Third and Elm Sts.
Dubuque.....8th and Washington Sts.
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Sioux City..325 Fourth St., P. O. Box 398
Waterloo.....1209 East Fourth St.

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Pittsburgh.....824 N. Broadway
Salina.....154 N. Fifth St.
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New Orleans.....4124 Toulouse St.
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Portland.....11 Exchange St.

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Baltimore.....19 E. Lombard St.
Cumberland .....18 N. George St., P. O. Box 172
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Indian Orchard .....
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Detroit.....5785 Hamilton Ave.
Grand Rapids..500 Shawmut Ave., N. W.
Hancock.....First Nat'l Bank Bldg.
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Saginaw.....1330 N. Michigan Ave.
Sault Ste. Marie.....

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Minneapolis.....324 N. First St.
Virginia.....413 Chestnut St.

MISSISSIPPI
Vicksburg.....1701-3 Levee St.

MISSOURI
Kansas City.....1422 St. Louis Ave.
St. Joseph.....920 South Sixth St.
St. Louis.....(See East St. Louis, Ill.)

NEBRASKA
Omaha.....1007-9-11 Jones St.
Union Sta. P. O.

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Camden.....Front and Division Sts.
Newark.....251 Ridgewood Ave.

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Binghamton.....82 Prospect Ave.
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Jamaica.....11 New York Ave.
Kingston.....O'Neil St., Near Broadway
Niagara Falls .....
Poughkeepsie.....Smith St. and N. Y., N. H. & H. R. R. Tracks
Utica..... 135 Hotel St.
Watertown..... 428 Court St.
Whitehall..... 22-23 Main St.

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Charlotte .....
Palmer St. & P. & N. R. R., P. O. Box 777.
Raleigh .....
.....204 W. Hargett St., P. O. Box 149
Wilmington .....
Surry St., between Castle & Queen Sts.
Wilson..700 Goldsboro St., P. O. Box 272

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Fargo——Fifth St. and Second Ave. N.

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Cincinnati.....67 Plum St.
Cleveland.....631 Hanna Bldg. Annex
Columbus.....330 Dublin Ave.
Dayton.....104-114 S. Wayne Ave.
Lima .....228 East High St.
Mansfield.....40 West Third St.
Steubenville.....324-342 N. Seventh St.
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Youngstown.....Jones and Brittain Sts.
Zanesville.....Main and 2nd Sts.

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McAlester.....8 N. Main St.
Oklahoma City.....4 West Park Place
Tulsa.....1-11 Boulder St., North

OREGON
Portland.....15th and Hoyt Sts.

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Beaver.....262 East End Ave.
DuBois....Weber Ave. and Franklin St.
East Greensburg..Clark and George Sts.
Erie.....1426 Chestnut St.
Harrisburg.....26 S. Tenth St.
Johnstown, Messenger St. and B. & O. R.R.
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Pittsburgh .....1202 Chamber of Commerce Bldg.
Pottsville..Railroad and Sanderson Sts.
Scranton.....Penn Ave. and Vine St.
Shamokin.....Fifth and Walnut Sts.
Williamsport.....Canal and Court Sts.
Wilkes-Barre....150 E. Northampton St.

SOUTH CAROLINA
Charleston.....3 Liberty St.

TENNESSEE
Chattanooga.....312 Pound Bldg.
Knoxville.....436 West Depot Ave.
Memphis.....671 South Main St.
Nashville..... 105-107-109 Broadway

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Dallas.....1008 Canton St.
El Paso, First and Kansas Sts.....P. O. Box 103
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Salt Lake City..108 W. Second South St.

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Norfolk.317-320 Nat. Bank of Com. Bldg.
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Bluefield.....195 Roanoke St.
Charleston..Broad St. and K. & M. R. R.
Elkins.....Railroad Ave. and First St.
Fairmont.....Auburn St.
Huntington...Seventh Ave. & Eighth St.
Morgantown.....175 Clay St.
Mount Hope.....P. O. Box 536
Mullens.....Box 55
Wheeling.....42nd and McCulloch St.
Williamson.....P. O. Drawer L

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Seattle.....304 Railroad Ave., South
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WISCONSIN
La Crosse.....Front and King Sts.
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Milwaukee..... 120 Jefferson St.

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Welding Metal

Is making sounder and tougher welds at a lower cost per lineal foot in thousands of welding shops.

If you have not tried Weldite, it will be worth your while to request samples, which will be gladly furnished free of charge to shop foremen and any others interested in welding.

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Bare and Flux Coated for Electric Welding

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D. & W. Fuse Works, General Electric Co

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A word to the buyer of gas

COMMERCIAL Acetylene is made to meet the most exacting requirements of the careful welder. This means that every cylinder we supply is full of the purest acetylene gas which can be made. There is no variation in the quality.

Commercial Acetylene is sold on the free loan cylinder plan, which means that when you buy Commercial Acetylene you do not have to purchase cylinders. You buy only the gas which you use. No matter how much gas you use, this is the best way to buy it.

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combination welding and cutting torch
Price, $60.00
Including Tips

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Including Tips

The BURCO—*The torch for*

Welders whose pride is perfect welds

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Including Tips

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for cutting
Price $50.00
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BURCO L. B. Torch
for Lead Burning
Price $8.50
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BURCO C. B. Torch
for Carbon Burning
Price, $2.50

BURCO Torches **mix the gases at the front end of the handle** in a mixing chamber which is far enough away from the flame to be unaffected by the heat.

The mixing chamber in the BURCO Torch is so carefully designed that it will function with a complete range of tip sizes from No. 1 to No. 20. **You do not have to change mixers when you change tips.**

BURCO Torches are designed on the even pressure principle. **Equal volumes of gases are consumed.**

BURCO Torches make eleven distinct mixtures of the gases, giving **the most perfect combination of gases obtainable.**

With the BURCO Torch you **save gas and time,** and make better welds.

BURDETT

BURCO Welding and Cutting Torches and BURCO Regulators represent a distinct advance in the construction of high pressure gas apparatus. Every one of the items illustrated here is a new and improved design, embodying features not to be found in any other line of apparatus.

For example

The BURCO Oxygen Regulator

is made for high-and-low pressures—A real combined welding and cutting regulator

(This is made possible by using a compression and expansion spring. Note sectional view of Burco Regulator below)

This is a Real Test Which BURCO Regulators Will Stand:

The diaphragm of the BURCO regulator is made of a special double fabric and composition rubber which renders the regulator very sensitive. Its fluctuation from wide open to closed is from 13 to 16 oz. on low pressures and from 2 to 2½ lbs. on high pressures. This is something never accomplished before in the history of regulator construction. It marks a distinctive advance in pressure regulators. Make this test of fluctuation on any other regulator and see for yourself how it compares with the BURCO.

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We also furnish Welding Rods of Cast Iron, Copper Covered Iron and American Iron for welding steel, Vanadium Steel, Nickel Steel, Cast Aluminum, Drawn Aluminum, Soft Brass and Phosphor Bronze, also Steel Electric Welding Rods both flux covered and uncoated.

Parsons' Manganese Bronze

Rolled Welding Rods—The strongest bronze welding rods made for Oxy-Acetylene Welding and High Fire Brazing of Malleable Iron, Brass and Bronze. The use of Parsons' Manganese Bronze Filler Rods in brazing malleable iron results in the strongest possible weld or braze and insures satisfactory work.

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A joint properly made with this solder is stronger than the original casting and is preferable to a welded joint.

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We furnish and will be glad to estimate on all kinds of brass and bronze castings.

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Roebling Welding Wire

Conforming to Spec. E1B and G1A of The American Welding Society

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Absolutely uniform in quality

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99.75% Pure Iron

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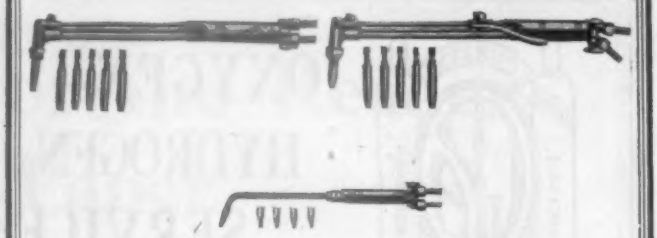
TRENTON, N. J.



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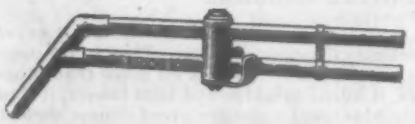

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BLOWPIPES for lead burning.

BLOWPIPES for heating work to be welded by the oxy-acetylene process.

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Cheapest in the End

Improve Your Torches By Using "Federal" Regulators

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Electrox Co., Peoria
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Swift & Co., Chicago

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Logansport Oxygen Co., Logansport

IOWA
Bettendorf Oxygen Hydrogen Co., Bettendorf

KENTUCKY
Kentucky Oxygen & Hydrogen Co., Louisville

LOUISIANA
Louisiana Oxygen Co., Inc., New Orleans

MANITOBA
Auto-Lite Gas Co., Ltd., Winnipeg

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Michigan Ox-Hydric Co., Muskegon
National Oxygen & Machinery Co., Detroit

MINNESOTA
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St. Louis Oxygen Co., St. Louis

MONTANA
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NEBRASKA
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OHIO
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Ohio Electrolytic Oxygen Co., Cincinnati

OKLAHOMA
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OREGON
Portland Oxygen & Hydrogen Co., Portland

PENNSYLVANIA
Burdett Oxygen Co., Philadelphia (plants at Chester and Norristown)
Burdett Oxygen & Hydrogen Co., Pittsburgh
National Oxygen Co., Erie

TENNESSEE
Burdett Oxygen Co., Chattanooga
Memphis Oxygen Co., Memphis

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Magnolia Gas Products Co., Houston

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(Says Smiling Dave O'Kay)

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Smiling Dave O'Kay
(EXPERT CUTTER AND WELDER)

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Burns Brighter—Lasts Longer

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There is no explosion chamber in a Smith Welding Tip. A Smith Tip does not splatter hot metal on the welder. The mixing chamber extends from mixing nozzle to tip, eliminating gas pockets, popping and back firing.

Only pure, heavy all-copper bars (not composition) are bored to make Smith Tips. That is why they cool best and last longest.

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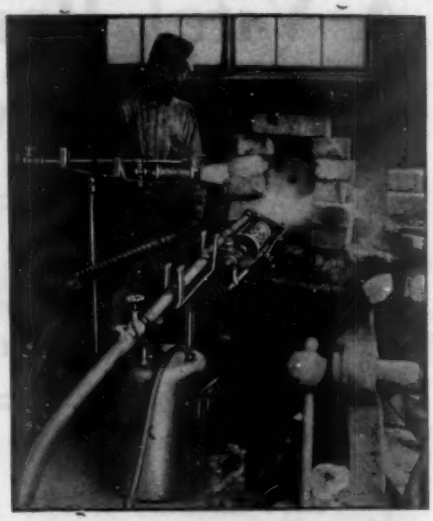
Send for booklet "Why A Smith Generator."

Exclusive Manufacturers of Welding and Cutting Equipment

SMITH'S INVENTIONS INCORPORATED
MINNEAPOLIS

WELDING "TIPS" No. 1



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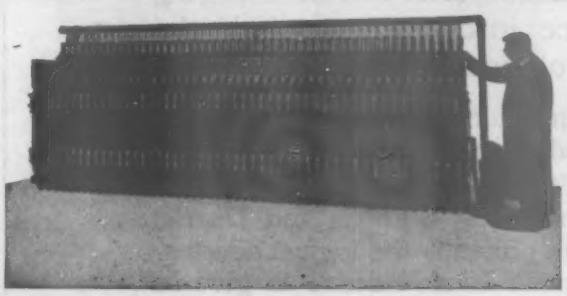

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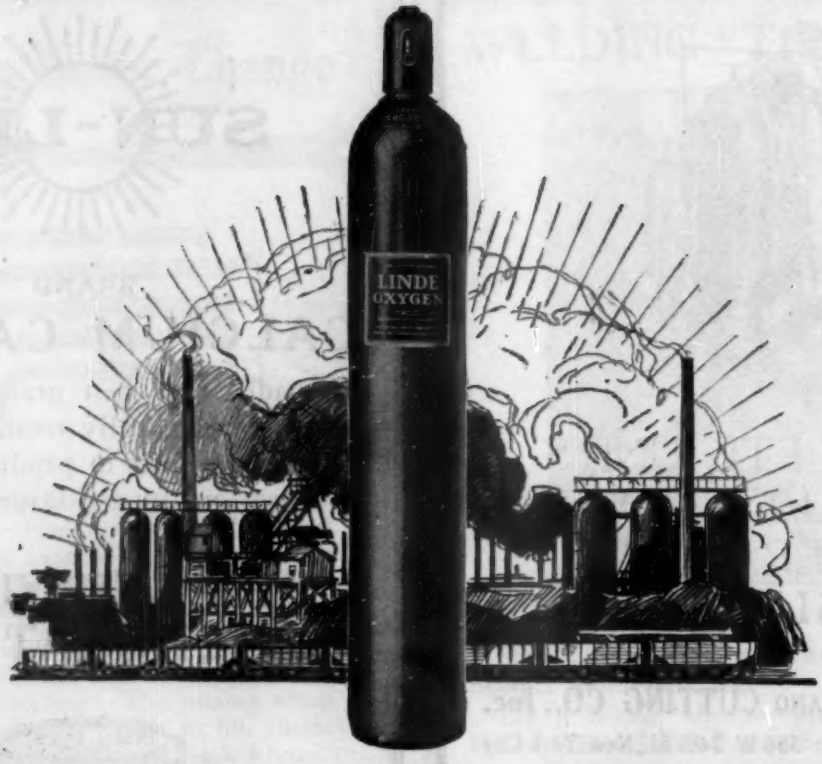

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ARC WELDING OF CAST IRON*

Procedure Followed by A. W. S. Committee in Making Tests of Metallic Arc Welds on Iron Castings

By W. H. Namack†

AS POINTED out in Part I of the paper on the above subject, the work of the Northern New York section was divided into two parts. The first consisted in drawing up a summary of the present state of the art in regard to the welding of cast iron and included such authentic information as the Committee could collect. There were a number of points, however, on which further data was needed. A program of investigations was accordingly carried out by the Committee on some of these points. There are still a number that remain unsolved and the Committee recommends that the American Bureau of Welding, through its Electric Arc Welding Committee give these points careful consideration with the view of assigning them to appropriate localities or laboratories for completion.

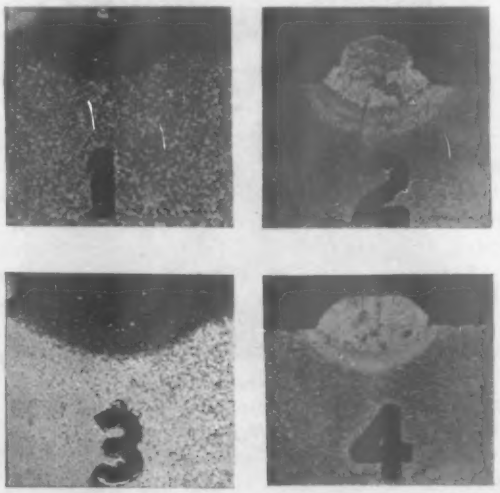

Fig. 1. Depth of Penetration with Long and Short Arcs.

The problem of welding cast iron by means of the electric arc is not a single definite problem which might be solved easily by making a few tests. In fact the Committee has discussed it from every point of view and has found not one, but many difficulties which confront the investigator from the start. The variables are many and the control of these variables is in some cases most difficult. The personal element is probably the greatest variable, but it can be made less dominating by proper selection in carrying out a series of tests although it is yet to be controlled in the practical application of arc welding. It is not the purpose of the Committee to here attempt a full discussion of the different problems involved, but rather to enumerate the various points which appear most important and which offer fields for investigation. The desideratum is a method which shall insure satisfactory machineability, low porosity, and a strength approaching that of the base material.

Proposed Program of Research

1. Determination of the proper current to get the best adhesion between filler and base metals.

On Arc Welding of Cast Iron

2. Determination of the proper electrode to get the best adhesion.
3. Prevention of the hard zone at the junction of the filler and base metals.
4. Prevention of free carbon and slag in the weld metal.
5. Study of straight versus reversed polarity.

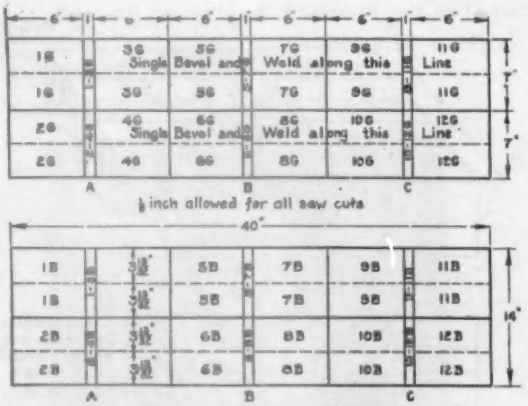

Fig. 2. Cutting Test Plates.

6. High versus low temperature welding.
7. Prevention of the closing of the "Vs" opening between plates while welding.
8. Multiple interlocking layers versus a single spirally deposited layer.
9. Single versus double V groove.
10. Method of determining the grade of the cast iron.

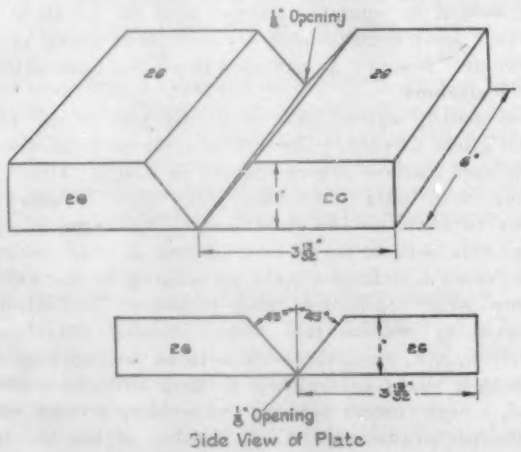

Fig. 3. Test Plates Ready for Welding.

In the course of its investigations, the Committee has considered the following points:—

(1) Preparation of the parts to be welded.

(2) Prevention of slag inclusions in the weld metal deposited.

(3) Suitable values of current for the size of electrode employed.

(4) Method of deposition of the filler metal and its effect on the strength and hardness of the weld.

(5) Reversed polarity versus straight polarity.

(6) Effect of long versus short arc.

*This report has been prepared under the auspices of the American Bureau of Welding. Presented at the Fall Meeting of the American Welding Society, Chicago, Oct. 1922.

†Chairman, Sub-Committee, Northern New York Section.

(7) Effect of speed of welding on the softness of the weld.

(8) The hard zone and its removal.

(9) The relative weldability of various grades of cast iron. (Tests were made on two typical grades at present in wide use.)

(10) Tests of electrodes with a view to ascertaining the most suitable materials, construction and characteristics for use in welding various grades of cast iron.

The above outline of the Committee's deliberations may seem to the reader as inconsistent with the Proposed Program of Research, but as already stated in the introduction the Committee could not solve all points by one series of tests, and therefore tests were made in accordance with a program based on the results of the Committee's deliberations. It was thought that the conclusions which could be drawn from such tests might clear up some of the points mentioned in the Proposed Program of Research.

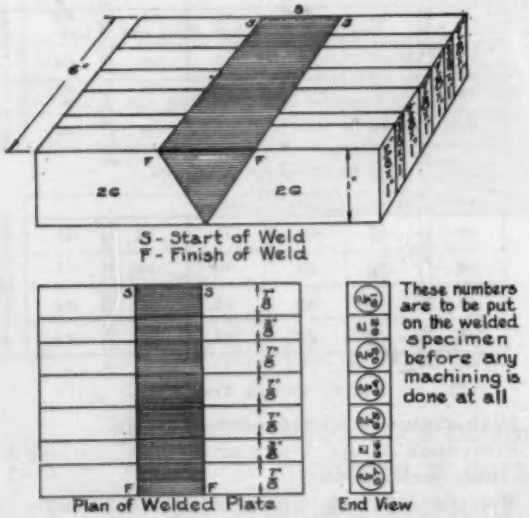
S- Start of Weld
F- Finish of Weld
Plan of Welded Plate
End View
These numbers are to be put on the welded specimen before any machining is done at all

Fig. 4. Layout of Welded Specimen Preparatory to Machining the Test Bars.

Preparation

The Committee decided that in the preparation of the parts to be welded the single V is better than the double V because in actual service the double V is in most cases, practically impossible. A single V was used in all the Committee Tests.

Slag Inclusions

It is usually agreed that gray cast iron is the most uncertain grade to weld. The difficulty seems to be due largely to the free carbon present which is called "kish." When welding with bare electrodes this "kish" causes a dark deposit to form on the weld metal. Chemical analysis indicates this deposit to be iron silicate or slag, which often times causes a defective weld by lodging in the weld metal forming what are called "slag inclusions." Two methods suggested to remove this "kish" seemed suitable to the Committee, viz., first, the surface to be welded may be subjected to a slight preliminary melting with the carbon arc, second, a high current value in the welding process may give the desired results. Mr. C. J. Holslag of the Electric Arc Cutting and Welding Company, on page 41 of the March, 1922, issue of the Journal of the American Welding Society, states that going over a cast iron surface with a 600-ampere carbon arc renders the subsequent welding process much easier than welding directly on an untreated cast iron surface.

The practicability of using a high heat in the welding operation would depend upon the thickness of the parts to be welded and the skill of the operator. It would seem that the localization of heat has a tendency to create an annealing effect and the Committee believes that the data incorporated in the test results will tend to show that this proposition to use a high heat value in the welding operation has some worth.

Current Values

For cast iron welding by the metallic arc process, the following current values have been found to produce the best results with average welding ability:

SIZE OF METAL ELECTRODE	CURRENT
1/8" Electrode (on plates up to 1/8" thickness)	up to 125 amperes
5/32" Electrode	135-175 amperes (depending on the thickness of the plate).

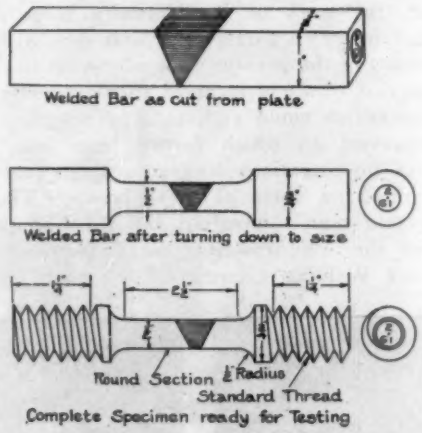
Welded Bar as cut from plate
Welded Bar after turning down to size
Round Section & Radius
Standard Thread
Complete Specimen ready for Testing

Fig. 5. Completion of Specimens for Testing.

The usual method of depositing the weld metal is to apply it in layers or beads lengthwise of the weld. In this way a series of interlocking layers is formed which, if brushed vigorously after each layer is deposited, should give a clean weld. Furthermore the heat can be kept low and consequently the expansion will be small. The deposition of metal by means of a single spiral layer was however, strongly advocated and this latter method was employed in performing most of the Committee tests.

Some members of the Committee advocated using reversed polarity to reduce the heating effect of the arc on the base metal but this suggestion was not adopted in the tests. Probably for some electrodes and for some kinds of cast iron, better results can be obtained with reversed polarity.

Length of Arc

The committee decided that an arc length not over 1/8" would give a deeper and more uniform penetration and would insure a stronger weld. In order to test this suggestion samples of long and short arc deposition on both steel and cast iron were given to Mr. T. S. Fuller of the General Electric Research Laboratory to analyze. The results are given in Fig. 1.

The Nitrogen Theory

Mr. Fuller investigated the three zones, shown in the photograph, Fig. 1, by means of photomicrographs. Sections taken at the top of the bead, at the junction of the filler and base metals, and in the lower dark zone showed traces of nitrogen in the form of dark needles. This nitrogen or "nitride" as it is called, was present in both the steel and cast iron welds. The presence of carbon together with the "nitride" is the cause of the hardening effect. The hard zone in the steel weld is soft enough to be machineable and gives no trouble. The hard zone in the cast iron was very hard and not machineable.

The four photographs in Fig. 1 show the depth of penetration and hard zones: for two gray cast iron welds (No.1 & 3) and two steel welds (No. 2 & 4).

The following remarks on each of the four photographs should be studied.

1. Gray Cast Iron. Short Arc with bare electrode. Note that the filler metal is amalgamated nearly to the bottom of the black area and that the black area is somewhat more shallow than in the case of photograph number 3.

3. Gray Cast Iron. Long Arc with bare electrode. The difference between "heat penetration" and "weld penetration" can be very clearly distinguished in this picture. There are two hard zones here: one at the bottom of the filler layer and the other at the lower edge of the dark area.

2. Steel with bead from bare electrode deposited with short arc. The hard zones are present but are not as troublesome as in the case of the cast iron, due to the fact that there is not as much carbon present.

4. Steel with bead deposited from bare electrode with long arc. The different zones can be clearly distinguished here.

Speed of Welding vs. Softness

As the result of a series of tests the Committee concluded that the speed of welding did affect the softness of the deposited metal, the slower speed in the case of either straight or reversed polarity gave the softer deposit of metal. The hardness tests were made with a Shore Scleroscope and the hardness numbers given herewith are the averages of about fifty readings each.

	Straight Polarity	Reversed Polarity
Slow	33	23
Fast	40	36

However, this should be regarded as of the nature of a hasty preliminary test which should be followed by a thoroughly careful and comprehensive research.

Fig. 6. Clamping Device.

Suitable Electrode

During the progress of its investigations, the Committee found that there were a good many different kinds of electrodes in use commercially for welding cast iron. It was therefore decided to investigate these electrodes as to their respective characteristics when employed in welding cast iron.

As a preliminary project, the Committee outlined a program of investigation to be carried through with seven commercial electrodes. These comprised the following types:

Bare wire, flux covered, alloy metal, and alloyed flux electrodes.

The Committee's investigations were confined wholly to testing these seven electrodes in accordance with the Specifications for Tests which are given below. The Committee feels, however, that further investigation is needed on some of the other items mentioned in the Proposed Program of Research given in the introduction.

After careful deliberation and consideration of the various elements and factors involved, the following program was adopted by the Committee as constituting a basis for a preliminary investigation, and in the belief that (with the many modifications which would doubtless be suggested as experience accumulated) it might come to be accepted as a Standard Method of Procedure for further investigations of this character.

SPECIFICATIONS FOR TESTING COMMERCIAL ELECTRODES

Size of Plate

The size of plate shall be 40" x14 ' x 1". One plate shall be cast for each grade of iron to be tested.

Method of Casting

The plates for test shall be cast flat in a green sand mould.

Chemical Analysis and Tensile Strength of each Material

These data shall be obtained from the coupon bars cut from the plates as shown in Fig. 2, and compared with the data obtained from the foundry test records.

Heat Treatment

The plates shall be allowed to cool over night in the sand of the mould to avoid any chilling action. No heat treatment shall be given to any plate.

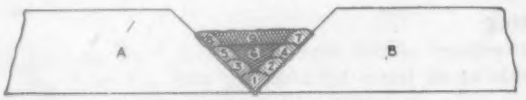

Fig. 7. Welding Method No. 2.

SIZE OF SAMPLES

For Welding

Plates shall be laid out as shown in Fig. 2, sizes as indicated.

For Testing of Parent Metal

The sample test bars shall be prepared according to the specifications of the A. S. T. M. from the coupons cut from the plate shown in Fig. 2.

Fig. 8. Four Welded Specimens Which Broke in Threads on First Two Tests, Turned to ½-Inch for Third Test.

PREPARATION OF SAMPLES

Cutting

Plates shall first be marked as shown in Figs. 2 and 3 so that identification marks will appear on each sample, and then cut as shown on Figs. 2 and 3. As an extra precaution, after cutting, the samples shall have the same marking stamped on one short edge of each as is stamped on the surface, so that, after cutting, each sample shall bear a special mark.

Bevelling

45° to the center, single bevel, as shown in Fig. 3.

METHOD OF WELDING

Kind, Analysis, and Size of Electrodes

The following electrodes shall be used:

(1) Bare wire	(6) Alloy wire
(2) Bare wire	(7) Alloy wire
(3) Coated wire	(8) Alloy wire
(4) Coated wire	(9) Composite electrode
(5) Coated wire	

These electrodes shall be $\frac{1}{4}$" in diameter, and a chemical analysis of each shall be made.

Current

Preferably 150 amperes in each test. The current actually used shall be recorded.

Polarity

Straight polarity (work positve and electrode negative) with all electrodes, and also additional samples with reversed polarity on the nickel and bronze electrodes.

Clamping

See Fig. 6. Plates shall be tacked at both ends and the center before the weld is started. These tack welds shall each be a single bead approximately ½" long.

Number of Layers

One spiral layer only shall be deposited to fill the groove in each test. The surface of the deposited material shall extend approximately ⅛" above the surface of the base material.

Cleaning

The surface of the deposited metal shall be kept clear of all scale at all times by brushing with a wire brush.

REMARKS

After the weld has been completed the clamps shall be left in place until one's hand can be held on the weld without discomfort. No artificial cooling shall be applied.

Just before the clamps are removed the welder shall stamp an "S" on the surface of the plate at the start of the weld and an "E" at the finish. A record shall be kept of the number stamped on the sample, the type of electrode used, the welding current, the time required for making the weld, the arc characteristics of each electrode, the number, length, and total weight of electrodes used on each sample, together with the weight of scrap ends.

TESTING

The plates shall be laid out to be cut crosswise of the weld into five (5) bars ⅞" x1", and two (2) bars ⅜" x 1". Beginning at the start of the weld the first bar should be ⅞" x 1", the next a ⅜" x 1", the next three ⅞" x 1", and the last ⅞" x 1". See Fig. 4. Lathe centers shall be drilled so that they will come in the center of the end of each of the ⅞" x 1" bars so laid out.

Then identifying numbers shall be stamped around the lathe centers on the ⅞" x 1" bars so that these numbers will appear on each end of bar after the ends are turned down to ¾" diameter, and also on the ends of each of the ⅜"x1" bars. The identifying numbers shall consist of the number on the sample plate followed by a numeral, this numeral being one (1) for the bar cut from the sample plate at the start of the weld and seven (7) for the bar cut from the sample plate at the finish of the weld, the intervening bars being numbered consecutively. That is, on sample plate No. 2-G the ⅞" x 1" bar at the start of the weld shall have stamped on each end 2-G-1, and the bar from the same plate at the end of the weld shall have stamped on each end 2-G-7.

The sample plates shall then be cut as laid out into the seven (7) bars, and each ⅞" x 1" bar shall be machined as shown on Fig. 5, no machining being done on the ⅜" x 1" bars.

The machinist shall keep a record of the characteristics of all of the test specimens as regards machineability of the welded portion.

Tensile Strength Tests

Tensile strength tests shall be made on each of the round test bars in accordance with A. S. T. M. Standards.

Hardness Tests

Scleroscopic hardness readings shall be taken on the deposited metal, at the junction of the deposited metal and the parent metal, and on the parent metal, on each of the ⅜" x 1" test bars.

Microscopic and Chemical Analysis

After hardness tests have been completed on the ⅜" x 1" test bars, these shall be used to obtain microphotographs of the juncture of the deposited metal and the base metal to determine, if possible, the cause of any excessive hardness. No chemical analysis of the deposited metal shall be made unless it is determined, after the various other tests, that such analysis would be desirable on any of these specimens.

Reports

All data collected, with the complete history of each specimen, shall be shown on the final report, together with such conclusions as may be drawn.

The Committee's Tests

The Committee selected two different grades of cast iron as base material for the tests. These two grades of iron are identified by the letters B and G and their trade names are turbine or cylinder iron, and gray cast iron, respectively.

Two methods of depositing the filler metal were used in these tests, namely, that as described in the Specifications, and another, METHOD No. 2, which is described below.

The welds made by METHOD No. 2 were made slightly different than those made in the General Electric Company. The following diagram (Fig. 7) will illustrate the cross-section of a weld as made by this method.

It will be noted from the illustration that this method allows the operator to deposit steel on the surface of the cast iron better and insures better penetration since the electrode can more easily be held perpendicular to the surface of the base metal while putting on each bead. The procedure is as follows: The parts A and B are first joined together by bead Number 1. Then beads numbered 2 and 3 are laid on so that they do not quite touch. Beads numbered 4 and 5 are next deposited and then filling 6 is laid down. More beads are laid on the cast iron and the filling-in process is continued so that the whole weld is made up of a succession of layers. The advantage claimed for this method is that the deposition of the filler metal by stages has a great tendency to anneal the deposited metal below the particular stage which is being deposited and in this way a softer weld is obtained.

The method used to make the welds in the Welding School at Schenectady was as stated in the specifications. The filler metal was deposited in one spiral layer after the parts A and B had been joined by a single bead at the bottom of the groove. This method is claimed to prevent slag inclusions and eliminate hard spots in the weld metal. The results of the tests did not confirm the superiority of this method.

It will be noted the number of the electrode used has no connection at all with the number of the plate which was welded by that particular electrode.

In making the welds, the test plates were set up as shown in Fig. 6. During the welding operation the characteristics of the arc were carefully observed.

After the welding operation had been completed the welds were allowed to cool over night in the clamps to prevent any distortion in the cooling.

While turning these bars into test specimens with the lathe, the machinist attempted to classify the bars according to their machineability.

All of the bars which broke while being machined fractured along the line of weld except, the hardest specimens 4 G 1, 5 G 7, and a soft specimen 8 G 4 which fractured nearly at right angles to the test piece. All of these specimens except the three mentioned showed a weakness which appeared to be due to poor amalgamation between filler metal and base metal. The fracture showed varying amounts of slag, burned metal and chilled cast iron.

The majority of the tensile specimens were approximately three-fourths of an inch in diameter instead of one-half an inch in diameter as prescribed in the Committee Specifications. This change to a larger diameter was adopted by the Committee when it was found that several of the test bars were breaking in the lathe during the process of turning. The four bars 3 B 3, 3 B 4, 9 B 4, and 4 G 4 broke in the threads on two attempts to test them in the tension machine and were then turned down to approximately one-half inch in diameter across the weld section as shown in Fig. 8. These four bars were tested to fracture.

Conclusions

From a consideration of the results of these tests, the Committee has reached the following conclusions:—

(1) That deposition of the filler metal to fill the weld V in a single spiral layer gives a softer but weaker weld than is afforded by depositing the filler metal in a series of parallel layers.

(2) That covering the surface of the cast iron with a layer of electrode material followed by a single spiral layer entirely filling the groove would be likely to give a weld having the desired characteristics.

(3) That the tests have shown electrodes 4, 5, 1 and 9 to give the best results for the B iron tests and electrodes 5 and 2 the best results for the G iron tests.

(4) That in so far as the variables concerned, i. e. variation of electrode strength and the personal equation of the operator may be neglected, these tests give an indication of the strength which may be expected from the various electrodes.

(5) That while the Committee was satisfied with the specifications as drafted, there are several changes which the Committee now feels should be made before other tests are undertaken along these lines.

(6) That in the arc welding of cast iron a short, steady arc, not over ⅛" in length, is essential.

(7) That in order to decrease the importance of the personal variable the automatic arc welding machine might be used.

(8) That the grades of cast iron used by the Committee can be welded, provided reasonable care is exercised in selecting the proper electrode material which is necessary depending upon the amount of free carbon present. The operator must have had experience sufficient to enable him to properly control his arc.

(9) That the readiness with which cast iron in general can be welded is more or less dependent upon the amount of free carbon present, i. e., the more free carbon there is in the cast iron, the harder that iron is to weld. In fact some cast iron welding jobs are not successful, and yet no account is taken of the character of the casting, but the welding process is blamed for the failure.

(10) That some so-called cast iron castings are not really cast iron but rather badly burned iron which cannot be welded. Such jobs should not condemn the cast iron welding process.

(11) That these tests are insufficient in number to be considered as a finished research, but that they are suggestive to further lines of investigation.

(12) That the standard test bar for cast iron should be larger than that prescribed by the American Bureau of Welding, i. e., the Welding Standard for brittle materials should be similar to the test bar recognized by the American Society for Testing Materials.

The A. S. T. M. Standard Tension Test for Cast Iron as given in the 1921 issue of the Society is as follows:—

"When tension tests are specified, the tension test specimens shall be turned from any of the broken pieces of the transverse test specimens, and shall conform to the dimensions shown in Fig. 2."

These dimensions are as follows:—

1¼" threaded ends, standard thread over 1" section. ¼" shoulder 1" in diameter between threads and test section. The middle section of the bar shall be turned to 0.8" diameter with a ½" radius at each end to connect with 1" shoulder. The total length of the test section from shoulder to shoulder is 1" and the total length of the test specimen is 3½" over all.

This test specimen might be lengthened for welding test specimens for the purpose of a clear section to be turned across the weld.

Prof. Frank P. McKibben, Professor of Civil Engineering at Union College is quoted as follows:—

"It would seem that the standard desired is some standard method of testing which would eliminate the great amount of machining necessary in turning out test bars. I would like to suggest a transverse bending test on a test bar of standard size. Such a bar could be easily made without much machining and probably without breaking as many test specimens as occurred in the Committee tests."

During the process of the investigations, the Committee has formulated several questions which, as yet, have not been satisfactorily and conclusively answered. An attempt has been made to outline a program of research and the solution of each point has an important bearing on the final conclusions.

1. What is the correct method of depositing the filled metal to secure a machineable weld with maximum strength?
2. Will preheating the welding surface with a carbon arc help in binding the filler and base metals?
3. What current is best for obtaining the strongest adhesion between filler and base metals?
4. Does the phosphor-bronze electrode offer any advantages as an antidote for the hard zone?
5. What advantages are offered by the use of a nickel electrode?
6. Does brushing the surface of each layer with a wire brush strengthen the weld?
7. How much is the hardness dependent on the speed of cooling?
8. Will silicon soften the filler metal in the weld?
9. Will hammering each layer of deposited metal while welding increase the strength of the weld?
10. What is the best way to apply the filler metal to secure the maximum strength, requisite softness, and minimum contraction?
11. What kind of electrode and what method of welding contribute to least porosity?

Glossary

The Committee has attempted to define several phrases which have been used in this paper:

Penetration

The word "penetration" is used indiscriminately in referring to welding work. The welder should make a dinstinction between "heat penetration" and "weld penetration." It is agreed by those who have studied the welding art that there is a difference between the depth to which the base metal is melted and the depth to which the amalgamation of the filler and base metals extend. This latter depth is usually what is spoken of as "penetration."

Polarity

In steel welding the usual practice is to make the work positive and the electrode negative. This is called "straight" polarity. When the electrode is positive and the work or base metal is negative, the welder calls this condition "reversed" polarity.

Speed of Welding

All references to speed of welding have been more or less understood to be a designation of the comparative rate of travel of the electrode without regard to the rate of deposition of metal from the electrode. There is no standard unit of measurement of speed of welding. As a matter of fact no one can specify a certain speed and be sure of obtaining desired results unless the amount of current is also specified.

Cold Shut

A "cold shut" is produced when any part of the surface of an ingot freezes before the mold has been filled, due to an interruption of the stream of metal.

Open Grained

The term "open grained" refers to irons, the fractures of which show large grains.

THE OXY-ACETYLENE PROCESS

Rapid Growth of the Industry Is Due to Great Economies Resulting From Use of These Gases for Welding and Cutting

By E. H. Smith*

On Monday evening, March 26, Mr. Smith broadcasted from Minneapolis Station, WLAG, this fifteen-minute talk on oxy-acetylene welding and cutting. Previous to the broadcast thousands of circulars were mailed to all parts of the United States, Canada and Mexico, announcing the broadcast and offering a welding and cutting torch to the person who should report the talk from the point most distant from Minneapolis. Atmospheric conditions seem to have been very unfavorable on the night in question, as many people at distant points were unable to receive Minneapolis at all. The prize for the best report from the most distant point was awarded to Mr. Wm. Shibley, of Gilby, N. D.

I want to talk to you tonight on a process that saves money. You have heard many lectures on methods of saving money, but this is something different. The business built up on this process has grown so rapidly and so quietly that few people realize its present proportions. This is the process of oxy-acetylene welding and cutting. Yes, I can hear you say now, "Oh, yes, that is what burglars use to cut into safes with."

For those of you who may not know, except in a general way, what oxy-acetylene is, I will offer the following explanation. The name oxy-acetylene comes from the two words, oxygen and acteylene the two gases used in welding. Acetylene is made from carbide. Carbide is made by mixing pure coal and lime together in a crucible and melting it in the terrific heat of the electric arc. When it has been thoroughly melted it is poured out at white heat into ingots weighing hundreds of pounds. The ingots are allowed to cool and are then crushed like stone and the carbide is screened to uniform sizes. It is now packed in tight iron drums in which it is shipped. Carbide will not burn, but is as inactive as so much crushed stone until it comes in contact with water. As soon as it is dropped into water the water is seen to boil violently. This is the acetylene gas being formed and machines called generators automatically drop carbide into water lump by lump forming gas as it is used in the welding torch. Due to its richness in carbon this gas burns with a very smoky flame unless used in special burners.

Now we must have oxygen—pure oxygen and nature has been liberal in her supply of raw material. Water is 8/9 oxygen by weight and air is 1/5 oxygen by volume, but it remains for man to remove the impurities. Passing an electric current through water separates it into hydrogen and oxygen and one gallon of water will make about 2100 gallons of gas, 1/3 of which is oxygen. Air is 1/5 oxygen and 4/5 nitrogen and the process of removing the nitrogen is somewhat complicated. I will describe it briefly: Air by means of a pump is compressed to a pressure of 3000 pounds to the square inch, fifteen times the pressure that our locomotive carry. One cu. ft. of air contains a certain amount of heat and if it is reduced to 1/100 cu. ft. in volume, all the heat of the whole cu. ft. is in this small 1/100 cu. ft. and the temperature increases enormously, unless it is removed during compression. In our large pumps the air is compressed in stages and between stages passed through coils of pipe submerged in cool running water which absorbs the heat. Otherwise the pump would burn itself out. Now, suppose we allow this air to expand again—what happens? Just the reverse. It gets cold—so cold that it turns to a clear bluish liquid. This liquid is more than 300° below zero. A drop of it on the hand feels like a live coal, but will freeze it instantly. It will freeze mercury, alcohol, ether, etc. A resilient rubber ball frozen in the liquid will fly into a thousand pieces when thrown to the floor. This liquid is still air, but it boils continuously because the temperature of the things it touches is like a red hot stove is to water. The nitrogen boils off first, leaving pure oxygen, just as the alcohol in your radiator evaporates first when you boil it, leaving pure water. An iron wire heated and plunged into liquid oxygen will burn with a brilliant white light. A piece of ordinary waste dipped in liquid oxygen and ignited will explode. With two small sacks of powdered charcoal about 2 in. in diameter and 12 in. long dipped in liquid oxygen, I blew up a 14 in. solid oak stump just like dynamite would have done the job.

This liquid oxygen is then allowed to boil and turn to gas and is collected separately and later pumped into drums for shipment.

A friend standing by the large compressor one day said: "It won't be long before you will have to move your plant—you will soon have all the oxygen out of the air in this neighborhood." I said, that machine pumping 10,000 cu. ft. of air an hour—to pump the air in one cubic mile would require 1,500 years and would make 78,000,000 drums of oxygen. The supply is inexhaustible.

This oxygen mixed with acetylene in the proper welding torch and burned will produce a heat equal to that of the electric arc. The flame of these two gases burning will melt fire brick and asbestos and make them run like water. It is the hotest known flame. This flame properly and judiciously applied will melt together and weld any metal.

Fifteen years ago when I told a friend, an expert mechanic that I could weld cast iron, he laughed and looked at me out of the corner of his eye and said: "You mean you can braze it, because cast iron can't be welded." I turned the flame on two cast iron pieces and he saw the metal quickly get red, then melt and run together. This was a revelation. I then told him I could weld not only cast iron, but alumium, brass, bronze, copper, in fact, any metal, but as was the case at the first auto show in Minneapolis where I exhibited a piece of cast iron that I had welded, no one believed it until they actually saw the work done with their own eyes. At my booth at this show a newspaper reporter came to me and looked at the sign above the booth which read something like this: "Oxy-acetylene welding of all metals." He asked me, "What can you weld?" I answered that I could weld anything but icicles and broken hearts. Since then I have eliminated icicles, as a few drops of liquid oxygen welds icicles, but I haven't made any headway with the hearts.

Most of you who are listening tonight have seen or at least heard of oxy-acetylene welding. Some of you perhaps do not believe that welding is a success, but to prove that it is when the equipment is properly handled, I will cite the following facts:

Less than 15 years ago I had four 100 cu. ft. oxygen drums to supply the Northwest with gas, two of which I loaned out to the several customers who did occasional welding. Today there are approximately 30,000 200 cu. ft. drums in service out of Minneapolis to take care of the rapidly growing demand for this process. The consumption for the United States is more than 75,000,000 cu. ft. annually.

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*President, Smith's Inventions Incorporated.

I find a great many cases where inexperienced welders ruin the reputation of welding, because of poor work. This is no fault of the process. You cannot expect to get music out of a piano unless you have first learned to play it. You do not condemn the piano.

You remember I stated an iron wire heated and plunged into liquid oxygen would burn very brilliantly. This fact is taken advantage of in oxy-actylene cutting. Oxygen has very little effect on iron when the iron is cold, but after it is brought to a red heat a jet of oxygen will burn the iron in its path and all that is necessary to do is to provide a tool with a heating flame and means for a jet of pure oxygen adjacent to the heating flame. When the iron becomes red hot in one spot, a valve is opened and pure oxygen rushes out in a jet to the hot metal and cuts it like a stream of hot water will cut into a snow bank, leaving the sides clean and clear. It will also cut under water.

To show how little is the general knowledge of oxy-acetylene I will tell you of one of the many curious incidents in my experience. A man gum shoed into the office one day and slid up to me very secretively and whispered that he wanted to see me privately. He evidently thought me honest enough to share his great good-fortune with him, for he then explained what a clean up we could make right here in Minnesota, one of the best states in the Union for his scheme. He required lots of stumps, and stumps is one of the biggest crops we raise in certain parts of Minnesota. We would simply take the cutting torch and snip, snip, snip—out comes a stump—and snip, snip, snip—out comes another. In a day what a slaughter we could make? For surely, if in five minutes it would cut a lump of hard steel a foot and a half thick, it would be "just pie" to nip off these soft pine stumps a couple feet thick. I was sorry to have to burst his bubble.

The process is only about fifteen years old in this country, and we must not expect to get the wonderful results possible with the little experience that we could gain in these short years. The industry as shown by my figures regarding the Northwest are true all over this country and with such a rapid growth it is not to be wondered that some mistakes and some poor work has been turned out. This industry was so important during the war that the government took control of the oxygen distribution. It was used, not only for welding, but very largely for cutting. An armor plate that would require days to cut to shape and large expensive machines to do the work was done in minutes with the use of the cutting torch. Steel 8, 10, 16 in. and thicker are cut like a hot knife cuts butter. Circles, squares, in fact, any shape can be cut as easily as on a straight line. Just for an illustration of the saving effected during the war when high carbon steel was very scarce and very expensive, I will cite the following example: A reamer for reaming shells required about ten pounds of very special tool steel. By using ordinary cheap steel and welding a ½ in. about a pound of tool steel around the edge to form the cutter, approximately $15.00 each was saved on one reamer and thousands upon thousands of these reamers were used. This is only one small item. Some of the things that are regularly welded are, barrels, tanks, tubing, furniture, wheels, coffins, airoplanes, locomotives, metal doors and other things too numerous to mention. On farm machinery there are a great many pieces, cast iron, malleable iron and steel castings. Threshing machine boilers spring a leak, water jackets on your gasoline engine may be cracked by freezing. In fact, the modern farm employs too many pieces of machinery for me to enumerate, but on all of these machines something breaks at some time or other and generally when it is needed the most. To get a new piece to replace it requires time, delays work and costs money. If you have a good welder in your town, he is the man for you to look to for in a short time he can make the broken piece as good as new and in nine cases out of ten can make it stronger by adding a little metal and making it thicker where it was broken. His charge for this work will be very reasonable considering the time saved and the cost of a new part.

Last fall a farmer in the southwestern part of Minnesota during the threshing season, laid off a crew of seventeen men at 10 o'clock in the morning because of a leak in the boiler. The owner of the rig went to the nearest town, a distance of six miles with the idea of getting a boiler maker to put on a patch which would require the services of two men for at least two days. The only man in this village equipped to do any work of this sort was a blacksmith who had had some experience in repairing boilers, but who had also learned oxy-acetylene welding. Instead of attempting to patch the boiler he took his welding outfit with him and in less than two hours after he reached the job, he had the crack welded up and work was again under way. Here was a saving of the time of seventeen men for at least two days, at a cost of much less than what the old method of patching would have been.

It is true that the inexperienced welders have caused some of you to become discouraged with welding, but conditions are changing and where twelve years ago there were perhaps only two or three welding plants in a state, today there are two or three in every town and it is up to you to find a welder who can do your work and do it well. I have too often seen a welder inexperienced in the work, take a broken casting, perhaps an inch square and melt into it about ⅛ of an inch all around, adding a little metal so as to cover the crack and then in his ignorance say he had welded the piece. If you see a welder doing this kind of work, take the piece from him and go to someone else. In order to produce a good weld the metal must be melted or cut away entirely through the piece at the crack or break and wide enough so that the flame can penetrate and deliver its heat to unite the metal at the bottom of the crack and keep it hot enough so that the metal added, knits with the original piece all the way to the top.

Most of you own an automobile. Sometimes the fender cracks or the frame breaks. Don't allow your repair man to put on an unsightly rivited patch which at the best will hold only a short time, but get your welder to weld it up, re-enforced with a thin piece of sheet iron welded to the inside if necessary.

Every year, hundreds of tons of farm machinery are gathered up in the small town by junk dealers at a few dollars a ton and this machinery is replaced at a cost of several hundred dollars a ton. A great majority of these broken and worn parts can be repaired by the welding process. The worn pieces can be built up with a piece of new metal and the broken parts welded and made sound. It is high time that the farmer take advantage of the opportunity offered him by reason of the welding plant in the small town. Think of the number of acres of wheat or corn you must plant, cultivate and harvest to pay for a new part on one of your machines costing ten or fifteen dollars. This same part in nine cases out of ten can be welded thoroughly and at a very marked saving. If you have a piece of metal that is broken or worn and want to get a new one, be fair with yourself and see your local welder first and compare his price with that of a new part. You can't lose anything and you may gain a great deal.

The Pittsburgh branch of the Metal & Thermit Corporation on May 1st will be moved from 801-807 Hillsboro Street, Corliss Station, to 1514 Fayette Street, N. S.

A modern welding shop is now being constructed at the new quarters and will be equipped with facilities for making Thermit welding repairs and relining crucibles. The new shop will be also equipped for making welds in lighter sections by means of the oxy-acteylene process.

A NEW USE FOR THE OXY-ACETYLENE COMBINATION

A few cases have been reported where the oxy-acetylene torch has been used in surgery, but such reports usually have dealt with the repair of artificial limbs. A more general surgical use for this combination of gases is indicated in a newspaper report that acteylene has been used very successfully as an anaesthetic. The proportions according to the report, were 60 per cent oxygen and 40 per cent acetylene.

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Another Revol

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THE BASTIA

In the Manufact

THE NEW REGO NOZZLE and seat cons and compression of the gas of the regula turn the full tank pressure of about 2,000 poun causes lightning-like movement of the regulato invariably in spontaneous combustion of the r of the best engineers in the industry for yea is embodied in REGO trade-marked regulator

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REGO Regulators are the last word in and patented safety features. The diaphragm ing of the diaphragm and bonnet in the event pressure is not theoretical. It is liable to happ holes in it while of some value, is not sufficie dous pressure. REGO shearing device does

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at cons n (patents applied for) prevents the ignition, from friction regula t. Operators, despite all cautions, will occasionally suddenly) poun quare inch, into the regulator with the valve open. This egulato and terrific compression of the gas at the nozzle, resulting f the r r seat. The prevention of this difficulty has been the problem or yea solution has finally been reached by REGO engineers and it gulator

OTH GO FEATURES

rd in a iform pressure regulators. They embody other exclusive hragm g device (patented) absolutely prevents the disastrous burst- event dental excess pressure in the body. This condition of excess o happ tank falls over or the torch back fires. A bonnet with vent suffici he diaphragm must also be relieved of the sudden tremen- does t omatically and safely.

NDEN ACCURATE REGULATION OF PRESSURE

re usua lied under considerable pressure. As the gas is used the ood wel economical cuts can only be obtained with a supply of gas ssure a me at the torch. Some regulators are fairly accurate as to and vic REGO regulators have been proven in **laboratory** and intain a ly uniform high or low **pressure** at the outlet and to deliver

DE RA OF SENSITIVE CONTROL

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VE ACTION

gulator ought together by the positive action of the gas pressure. d by sp Pressure of gas against the interior of the diaphragm pulls t nozzl pressure of the nozzle against the seat increases in the same the bod regulator—the more pressure—the tighter the seat. There worn-o less springs.

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BRAZING LOCOMOTIVE CYLINDERS

An Emergency Repair Which Will Stand Up in Service if Properly Made—Saves the Time of Preheating

By R. L. Carnahan

BRAZING broken section with a strong bronze joint makes a very good affair if the job is properly executed. I is easy to tell whether the brazing has been done well or not, because a properly brazed joint when broken will expose very little of the bronze. In other words, the well brazed joint is sufficiently strong to tear or break out the cast iron in large crystals when the weld is tested. A clean breaking between the cast iron and the bronze would show that the brazing had not been done properly. It is often remarked that cast iron cannot be brazed successfully, but this idea seems to be growing just a little bit old fashioned, because of the work which actually is being done. Today there are some welders who would pronounce a well brazed job to be almost as good as a weld.

When making a brazed joint, little or no preheating is required, although the amount of preheating depends upon the nature of the pot and its size. As in the case of the welded joint, it would be necessary to use some heat on a locomotive cylinder, but on a free section, like a broken drill press foot the heat from the torch would be enough.

I have successfully brazed boilers and feed pump cylinders without stripping or removing the pump. The job was pronounced successful immediately upon the completion of the job, and it actually gave several years' service.

The first and about the most important thing to do in preparing one of these bronze welds is to chip out the break thoroughly, and make a good 90 degree V from either one or both sides. The width of a single V will be twice the thickness of the metal and of the double V the same as that of the metal. Then chip the scale away from each side of the V back a distance of one-half the thickness of the metal.

Cut the metal cleanly. Do not break out chunks, and leave a good surface on which to braze. The braze will be perfect only on clean, smoothly cut surface. Bear in mind, too, that when the piece is beveled from both sides it requires far less filler rod than when it is chipped from one side only.

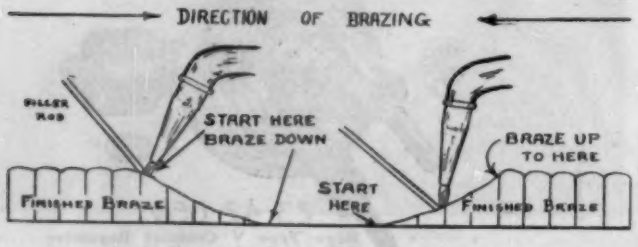
A Brazing Crew and Three Views of a Cylinder Brazing Job. 170 Pounds of Bronze Used on this Cylinder.

I always prefer to use a good tobin bronze filler rod and a good flux, and when I am finished welding the surface, I use a manganese bronze on top.

Heat a large section until it is too hot to hold your hand on it. Small pieces can be warmed up with the torch. When it has reached the point where you cannot touch it, you are all ready to braze. Use the same sized tip you would use to braze a like sized section. The best way to heat the flux is to use a section of the filler rod and dip it into the flux. A convenient method is to keep the flux in a flat box, bend a small portion of the filler rod at right angles, heat it and dip it into the flux box. After that keep it near the flame so that it will stay good and hot.

The correct position for the rod and torch is about the same as for backward welding of steel. This position will give the best results on horizontal work. The same thing applies to overhead work. I have never been able to get good results by any other method. A careful study of the illustration will show that there is nothing complicated about the process.

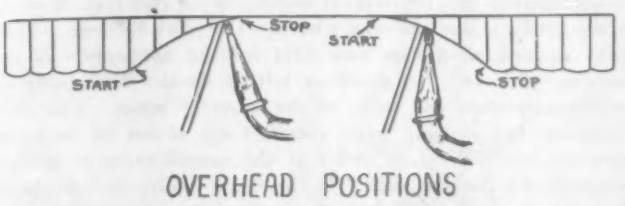
Heat the line of the braze for a short distance until the flux will just wet it, then quickly raise the heat a trifle and apply the braze. It should flow into the smaller spots like so much water. Now here is the trick in bronze welding. Just as you apply the flux a very thin spot on the surface is raised to a



Position of Torch and Filler Rod for Horizontal Brazing.

high temperature. If too small a tip is used, or the flame is held too far away, a thick section will be heated and this little spot burned. The bronze will not flow then. Likewise, if a welder is overcautious, and does not use enough heat, he will get sad results.

Overheating the applied bronze will simply cause it to come off. If you remelt it to clear the surface, you will have trouble in having more bronze stick to the surface, therefore, it is best to have the zone cover a space three or four times the thickness of the metal. As you gain in skill you can shorten up the

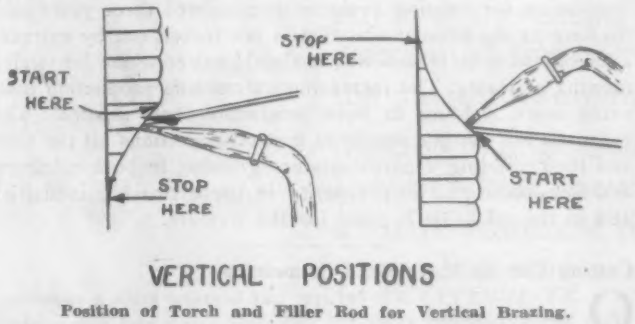


Position of Torch and Filler Rod for Overhead Brazing.

zone and increase your speed, but never try to fill up a thick deposit in one place. Keep moving to prevent overheating.

After completing a braze, I think it a good policy to warm up the work well. I think the conditions during the brazing tend to collect a layer of white next to the deposit. I have found such a layer present in a small degree on heavy sections, but if the braze covers a good area of the metal I do not think it will cause a failure. In my experience it never has.

When handling a locomotive cylinder, first remove one or both heads of the piston. Don't bother with the valve, unless the break runs into the valve chamber. I have brazed cracks in the boiler of a cylinder with the bushing removed and the



Position of Torch and Filler Rod for Vertical Brazing.

bushing in place. If the bushing is broken it may be welded with manganese bronze, then chipped out smooth, but no cylinder welded with a broken bushing in place will ever be round.

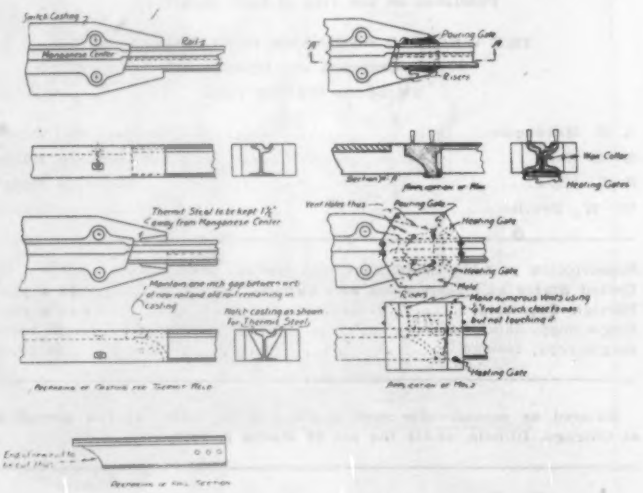
Chip out the breaks as outlined above, then put a few points of charcoal in the inside of the cylinder. Heat the outside with the charcoal on the front end. When the job is just too hot to touch, you are ready to start brazing. Reinforce as much as you can, and after completing the braze fire it with charcoal again and allow the whole job to cool down slowly. The photographs show one job on which 175 lbs. of bronze was used to fill in the break, using a ¼ in. rod. Of course, a little more can be deposited on horizontal work.

The best way to learn this work is to practice on some old cast iron. Give the pieces a bending test and see where they fail. When the braze will pull out the cast iron in large crystals and expose a very little of the bronze, you will know that you are to learn the trick.

REPAIRING ARMS OF IRON-BOUND SPECIAL WORK

A surprisingly great saving can be made by Thermit welding in connection with repairs to broken or loose arms in iron-bound frog mates or switches.

These repairs can be made at a remarkably low cost and without even removing the broken or loose parts from their location in the track. It is only necessary to remove about one or two yards of paving around the defective parts, cut out just enough concrete, or paving foundation, from under the rail to allow for application of mold boxes and chip away sufficient cast iron metal to permit the Thermit steel to flow between the rail and the casting and thus amalgamate with both parts. The accom-



Repairing Arms of Iron Bound Special Work.

panying drawings show in detail the welding procedure to be followed.

It is estimated by the Metal & Thermit Corporation that such repairs on an average can be made at the following cost:

Thermit welding materials, about	$30.00
Labor, about	20.00
Total, about	$50.00

In actual experience some repairs are said to have been made for as little as $16.00 per broken arm. The quantity of material required, of course, depends a great deal on the size of the rail and other circumstances, but the cost should average somewhere around the above-stated figures.

In all cases, frog mates or switches repaired in this manner have been restored to many more years of useful life. In one recent case in Joliet, Ill., a total of two Thermit welds made on one broken switch and one broken mate is reported to have paid for the cost of the whole outfit. In another instance in Providence, a similar repair of the broken arm of one piece of special work containing one mate and two frogs saved having to purchase a new layout at a cost of $1,800.00.

The same outfit can be used for this purpose as employed for manufacturing new frogs from short pieces of rail and for making welded compromise joints.

The National Oxygen Company is removing its general offices from 14 East Harrison Street to its factory at 5811 West 66th Street, Chicago, Ill. They forecast greatly increased oxygen production.

The Prest-O-Lite Co., 30 East 42nd Street, New York City, has acquired about eight acres at Tulsa, Okla. On this plat of land they will erect a new plant to cost $250,000 including the cost of the machinery. The parent company is also contemplating the building of another plant on an adjacent site for the Linde Air Products Co.

The Welding Engineer

Reg. U. S. Pat. Office.
Published on the 17th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,
608 S. Dearborn St., Chicago, Ill.
Telephone Wabash 7134.

L. B. Mackenzie.....President and Editor
H. S. Card.....Associate Editor
R. L. Miles.....Associate Editor
W. W. Brothers.....Associate Editor

Subscription payable in advance and postage free.
United States and possessions and Canada.....$3 a year
Foreign Countries ..... 4.00 a year
Single copy, domestic .....25 cents
Single copy, foreign .....30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 15th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails.

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VOLUME 8 APRIL, 1923 NUMBER 4

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Tank Welding Offers Huge Possibilities

ENGINEERS have finally been convinced of the practicability and economy of the welded storage tank, regardless of dimensions. The experiments made in Oklahoma this winter were made under very trying conditions, but fortunately the welding was done by capable men. They learned things when they laid the bottom on the first monster tank. Then when the time came to lay the second bottom they were able to cut the cost of the job nearly in two. It was quite an undertaking to weld these bottoms and roofs and keep pace with the riveting crews, who have had an opportunity to get thoroughly organized for this type of work. Much credit is due the men who saw the work through. They have opened up a vast new field for the application of the welding process. No doubt is left as to the desirability of welding bottoms and roofs of the monster tanks. This construction has already been specified on scores of tanks of monster size. Next in order is the specification of welded construction for the shell. If the same ability is brought to bear on the problem when that experiment is tried, we can soon expect to see the largest storage tanks in the oil fields welded at every joint.

The Business Outlook

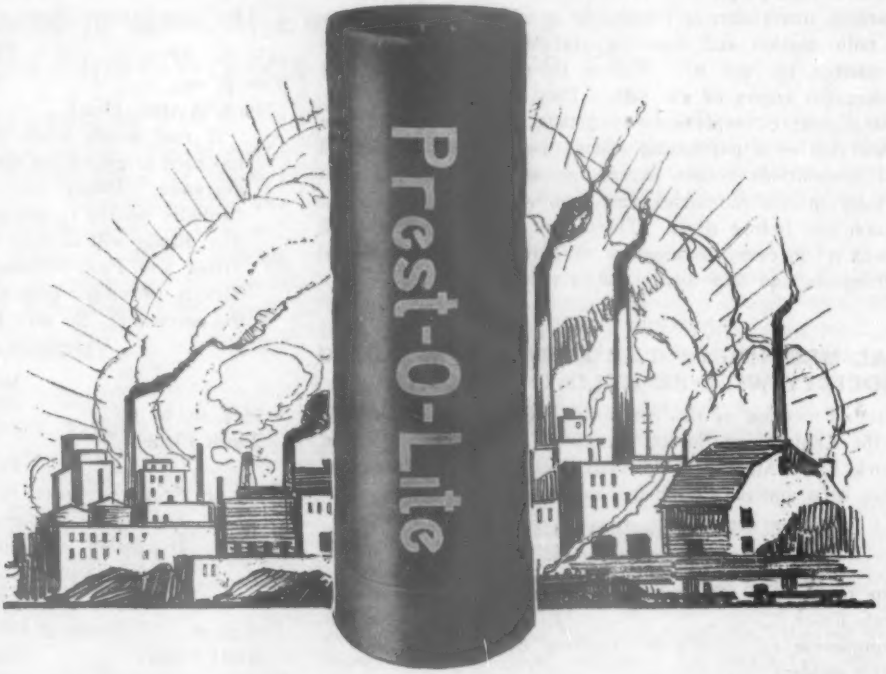
JUST how far the present general business conditions affect the welding industry is not so very important. The important thing is that present conditions are beneficial. The general trend as far as welding is concerned can be noted from the construction of a number of new oxygen-producing plants and the announcements of new lines of apparatus for welding and cutting. It is a program of expansion and development, and promises to make 1923 an interesting year, taking an upward course all the way. There is far less uncertainty and discontent than existed a year ago, and a good deal better foundation for existing business than existed three years ago. So long as the present situation is not forced out by extravagance there is no reason why it should not continue for twelve months at least. The increasing automobile production indicates more welding in both production and repairs. The railroads are getting nearer to normal conditions all the time and their welding departments are growing in both efficiency and importance. The prosperity in these two big industries and in the oil fields is good for the welders.

Cutting Can Be Made More Economical

OXY-ACETYLENE cutting has become such a commonplace process, both for reducing scrap and for production of new parts, that it is easy to lose sight of the possibilities for working out even finer economies. A great deal of gas is wasted in cutting operations through the improper selection of tip sizes, pressure adjustments, imperfect apparatus and lack of standards of operation. And usually when gas is being wasted some time is being wasted, too. The user is not altogether to be blamed for the misjudgment in the selection of tip sizes and adjustment of pressures. He is often trying a laboratory chart adjustment under field conditions. The correct pressures should be worked out to fit each individual case and a standard practice adopted which would do away with the burning of gas when the torch is idle. Remarkable economies have been effected in cutting operations by having these details watched carefully and providing facilities for checking imperfections in apparatus or gas lines, which may well turn out to be expensive leaks.

Tell Them All About Welding

MORE welding will be done when more people know about its possibilities. Both the gas and the electric processes have progressed far beyond the experimental stage as far as the making of ordinary types of joints is concerned, and yet the public is not well informed about welding. To the average layman a weld means a joint made by a blacksmith. If he has a broken piece of metal to be repaired he looks for a spreading chestnut tree. The modern welding shop employs processes



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DISSOLVED ACETYLENE

which are not popularized through the school book classics, but modern welding is saving millions of dollars in production and repair work, and people are generally interested in economy. An apparatus manufacturer broadcasts a talk on welding from a local radio station and receiving stations hundreds of miles distant attempt to "get it." Failing to receive the talk they write direct for copies of the talk. They want to know. Another manufacturer's representative gets a large audience from the membership of a purchasing agent's association. Trade and technical associations solicit papers on welding subjects relative to their specific industries, and show a keen interest in the information put before them. There are opportunities to "tell them about it" in every community. Welding enthusiasts should search them out and take advantage of them.

ANNUAL MEETING OF THE AMERICAN WELDING SOCIETY WILL BE HELD THIS MONTH

The annual meeting of the American Welding Society will be held in the Engineering Society Building, 33 West 39th Street, New York City, April 24th to 27th, inclusive. The program, which has been announced for this meeting, is as follows:

TUESDAY, APRIL 24, 1923

MORNING

9:30 a. m. to 12. Committee on Training of Operators,
Eleventh Floor. J. C. Wright, Chairman.
Completion of courses for training of both gas and electric welders.

9:30 a. m. to 12. Resistance Welding Committee,
Tenth Floor. Herman Lemp, Chairman.
Completion of summaries setting forth the present state of the art. Consideration of a research program and assignment of specific problems to appropriate laboratories and individuals.

AFTERNOON

2:00 p. m. Electric Arc Welding Committee,
Tenth Floor. H. M. Hobart, Chairman.
Reports of progress from sub-committees on standardization of arc welding apparatus, cast iron welding, applications of arc welding to ship construction, appointment of sub-committees on welding of non-ferrous metals and manganese steel. Recent developments in the electric arc welding field.

EVENING

8:00 p. m. Committee on Welding of Storage Tanks,
Room 1601. J. C. Lincoln, Chairman.
Report of progress, revision of existing specifications.

WEDNESDAY, APRIL 25TH

MORNING

9:30 a. m. to 12. Business Session of
Room 2, Fifth Floor. American Welding Society.

PROGRAM

1. President's Report of Year's Activities.
2. Reports from (a) Finance Committee.
   (b) Membership Committee.
   (c) Meetings and Papers Committee.
3. New Developments in Welding Field.
   (a) Electric Welding—W. L. Warner.
   (b) Gas Welding—G. O. Carter.
   (c) Resistance Welding—Hermann Lemp.
   (d) Thermit Welding—J. H. Deppeler.
4. Report of Teller's Committe on Election of Officers.
5. Introduction of New President.

AFTERNOON

1:30 p. m. Inspection Trip to Third Avenue Railway System Shops, 65th Street and Third Avenue.
Through the courtesy of the Third Avenue Railway System an opportunity is offered to members to see the applications of welding in a modern street railway shop. Members will assemble in front of the Third Avenue Railway System Shops at 1:30 p. m. sharp.

EVENING

7:00 p. m. The Second Annual Dinner of the
Park Avenue Hotel. American Welding Society.
A real worth while dinner and get-together meeting has been arranged for this year. A good time is promised everyone. Plenty to eat! Good talent! You are cordially invited to attend and bring along your friends. The dinner will be held in the Park Avenue Hotel, 33rd Street and Park Avenue, starting at 7:00 p. m. sharp. Tickets ($5.00 per person) may be obtained by writing to the secretary. Be sure to make your reservations early.

THURSDAY, APRIL 26TH

MORNING

9:30 a. m. to 12. American Bureau of Welding.
Tenth Floor.

PROGRAM

1. Progress reports by research committee chairmen.
2. Election of officers.
3. Discussion of policies.
4. Plans of future activities.

AFTERNOON

2:00 p. m. Board of Directors, American Welding Society,
Ninth Floor. (Including retiring and new members).

PROGRAM

1. Review of progress during past year.
2. Introduction of new President.
3. Plans for coming year.
4. Appointment of Committees (a) Executive.
   (b) Membership.
   (c) Finance.
   (d) Meetings and papers.
   (e) Revision of By-Laws.

2:00 p. m. Committee on Specification for Steel
Tenth Floor. to be Welded, W. J. Beck, Chairman.
Report of progress, plans for future work, including such investigations as are necessary to enable committee to draw up specifications for steel.

EVENING

8:00 p. m. Technical Sessions of American Welding Society.
Room 2, Fifth Floor.

PROGRAM

Welding of Unfired Pressure Vessels, H. L. Whittemore.
Training of Welding Operators, J. C. Wright.

FRIDAY, APRIL 27TH

MORNING

9:30 a. m. to 12. Gas Welding Committee,
Eleventh Floor. S. W. Miller, Chairman.
Reorganization of committee, plans for future activities.

AFTERNOON

1:30 p. m. Inspection Trip.
Details will be arranged later.

J. W. Lattin, Sacramento, Cal., has been awarded the contract for a new one-story machine and welding works by the Readers Welding Works, of that city. The estimated cost is $30,000.

The Gibb Instrument Company, Bay City, Mich., manufacturers of electric welding equipment, has increased its authorized capital stock from $75,000 to $175,000. In order to provide for increased manufacturing facilities to handle a rapidly growing business, $40,000 of the increased stock was sold at par. Mr. F. Luchs, formerly chief engineer for the company, has opened a new sales office in the General Motors Building, Detroit.

PRIZE WELDING STORIES

Building up Rail Ends—Cutting a Cast Iron Pipe—Welding a Sixteen-Inch Pipe

FEBRUARY PRIZE STORIES

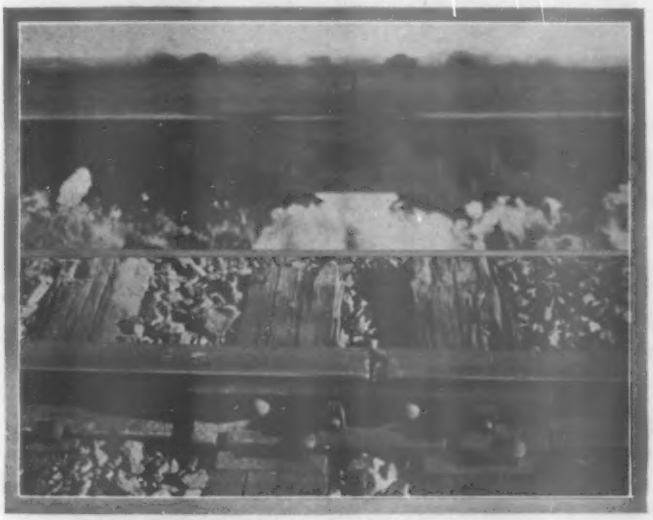
The following three stories have been selected from those submitted in response to our advertisement published in the February issue of THE WELDING ENGINEER. Announcement of the prizes awarded for the stories called for in the March issue will be published next month. In all cases the awards have been made on the basis of the practical value of the instruction contained in the story, from the point of view of the man who desires to accomplish a similar job.

First Prize

BUILDING UP RAIL ENDS

C. Wise, New Mexico

Haven't seen much printed matter on track welding, such as building up frogs, switch points and rail ends. Rail end work is rather new, although a good many experiments have been carried on for some time, so I am giving our method of building up battered and chipped rail ends. Have built up 3,950 ends since last August and haven't had one that failed.



Above, Welded Rail. Below, a Chipped Rail Before Welding.

We use a No. 15 tip and No. 2 steel. First the rail is heated to a cherry red on the running edge, and this edge is pounded in to make the rail even, like a new one. Then the top is heated the same way and the surface or skin broken with the torch, and all the old metal of the chipped part either run out or worked in, using care that no holes are covered up. Now apply the metal and weld right over the joint, providing the crack is not more than ⅛ of an inch. When enough metal has been put on, smooth over with the torch, using a slight excess of acetylene and hammer fairly smooth. We use an ordinary machinist's hammer for this. Now have the weld red hot and use a blacksmith's flatter on top which the helper strikes with an 8-lb. sledge hammer. This should leave the weld perfectly smooth. Heat again to a red heat right across the point and take a hot cut chisel and cut straight across.

The cutting is the most important of all. If the welder misses only a fraction of an inch from the original joint, then when the rail cools and pulls apart its liable to chip or take along a piece from the opposite rail. The chisel must be well drawn out so it will be able to make deep cuts and yet not leave a wide opening.

After cutting, heat the parts on both sides red hot again and use the flatter once more. This time start the flatter on the running side of the rail, come up and over the top and down on the outside and back again. This will leave the rail about the same shape as a new rail.

Where rails are ¼ in. or more apart, weld each rail end separately, using the same method as when welding straight across. We use a carpenter's square (or use a straight edge) which we lay over the rail surface. This will show how much must be built up. Be sure the joints are tamped up level at first.

The picture shows a chipped rail, such as we are building up, and a welded rail after five months in the main line. Some of the heaviest engines, pulling 100-car trains run over these joints.

Second Prize

CUTTING A CAST IRON PIPE

C. M. Johnson, Oklahoma

Quite a few difficult jobs that may help some welders with less experience in this line of work have come my way. Of course, every welder who has had any experience whatever in welding knows the old enemies, expansion and contraction, especially on castings of iron, aluminum and steel. I have a little information and experience of my own that a couple of companies turned down and also constructing engineers said was impossible. This was cutting a 1⅛ in. thickness and 30 in. in diameter casting used on the water main for the city water works, and both ends to be used. This was to be cut in two about the center without cracking or splitting open.

Successful Cut on a Cast Iron Pipe.

I first had my helper fill this length inside with wood and build as good and as hot a fire as possible to get the expansion on the casting. Cast iron cannot be cut with a common cutting torch, so I took my welding torch and put on an extra extension to keep it as far away as possible from the heat. I used a No. 10 welding tip, drew my line around the casting and commenced playing my torch from the shortest end to the line, to help out with expansion. I did this for about five minutes and then started my hole through by turning on more oxygen and turning off some of my acetylene. When I had bored the hole through I commenced cutting out the line, cutting about ¾ of an in. path around, using about 90% oxygen at times. When I finished up at the starting point, that is, after I cut all the way around, I played my torch back and forth where I finished for about five minutes to gradually draw the heat to each edge where I finished.

It took me just two and one-half hours to cut this joint in two, but it is a good idea to keep a good hot fire in the joint all the while the operator is cutting and the helper is rolling the pipe, if it is in a position to roll.

The small sketch illustrates how we started this piece of work. These two pieces of cast pipe never showed a sign of a crack when tested by the foreman and the superintendent.

Third Prize

WELDING A 16-INCH PIPE

G. H. Hab, Iowa

I was called out on a welding job for a concrete piling company not long ago, and they had a large 16 in. pipe that was broken. Now this pipe had to be straight after it was welded and also to hold, as they use it to drive down 42 feet in the ground, after which it is filled with concrete and pulled out, while another pipe drives the concrete out leaving a solid concrete piling in the ground. The pipe gets crystallized after using very long and during the welding process it will warp.

When I started on this job I cut the broken and jagged edges off even, then trimmed the edge off in a V shape and tacked the pipe in four places. At the last tack I kept on going all the way around without a stop. Can you think what I had when completed? I had a regular rainbow. I have been using the torch for seven years and no one ever told me anything about welding pipe until then, and the man who was in charge of the piling job laughed at me and said, "Well, boy, you will learn some day." Right then I asked him to explain, as I am not one of those know-it-all welders. He told me what to do then.

I cut the pipe, got it straight and tacked it in three places each about 2 in. long, then I preheated it about an hour with good fine dry wood, meanwhile rolling the pipe so as to get the heat even all around. Beginning at one of the tacks I welded about 3 in., then went to the next one and welded the same, then to the next one and back to the first weld and went about 2 in. to each weld until the pipe was done, making a mistake by covering it all up and leaving it to cool.

The next day they called me and said the pipe had broken with the first lick of the big 10-ton hammer. I sure was discouraged by this, but I made up my mind I would weld that pipe or know the reason why. I had the company send for some Norway iron, as I was out of it. The next day I went on the job and found that the pipe, where it had broken, was so hard a file wouldn't touch it at all, but this showed me what the trouble was.

I went ahead and welded it once more, but kept a fire under the pipe all the time. When the weld was completed, I built a big fire around it and kept it there for three hours, turning the pipe all the time, or every fifteen minutes. As the fire would draw the pipe down, I would keep the high or bowed side up. The day I did this last weld we had six below zero weather, and this work was done outdoors, so you see why I kept the fire going. The next day I went to look at the pipe, but by the time I got there they had had it in the ground four different times, and it held and was perfectly straight. Since then I have made sixteen welds like this one and had but one break, and this was caused by a twist in the derrick and ten below zero weather besides.

The pipe in this job was ½ in. thick and I made a reinforced weld besides. The pile driver is using this same pipe today, and is driving ten to twelve every day with it.

WELDING TRUCK ROLLERS

By A. W. McClary

Some of my regular customers, who are owners of Cletrac Tractors have had trouble in getting the new improved deep flange truck rollers as promptly as they wish them, so they have been bringing in their old type rollers for us to extend flanges to same depth as the new type. These rollers are of chilled cast iron and require so much welding to get them to proper size that it is necessary to preheat them to avoid cracking. In doing so you take the chill from the roller, leaving it much softer and with less wearing quality than a new one. A new deep flange roller sells for $10.80, and after welding a couple I found that $8.00 was the very least I could charge for this work, and at that only made a small profit. At this price it would be advisable for the purchaser to get a new one, due to superior wearing quality. They could not get new ones and continued to bring in their old ones which I would rebuild, more for accommodation than for profit. The demand for this work increased to such an extent that it became necessary for me to devise a method where there would be more profit.

The method of welding was to have two steel rings made by a blacksmith to the correct size of the roller, preheat the roller to a cherry red and then weld the ring on, making the weld solid by fusion from both sides. The same roller was then put back in the preheater and a hot one taken out in order to do the work as quickly as possible and with minimum gas consumption. My latest method using the arc, is to weld two lengths of ¼ in. cast rod together for an electrode, dip the same in a thick carbide slack from the generator, preheat as before, use high amperage and weld one ring on while it is very hot. Weld from both sides and you will have a weld free from air holes, solid and strong. The metal will be of a little harder nature than from an acetylene weld which is a little to our advantage.

THERMIT WELDING HOLLOW CASTINGS

Thermit welds involving difficult ramming were made early this year on two castings, one a cast steel hydraulic pipe flanging machine, the other a cast steel pipe proving machine, for the M. W. Kellogg Co., Jersey City.

The broken sections of the flanging machine averaged about 1¾ in. in thickness, varying from 1½ in. to 3 in. In preparing this casting for welding, the hollow broken parts at the factured

Thermit Weldon Pipe-Proving Machine.

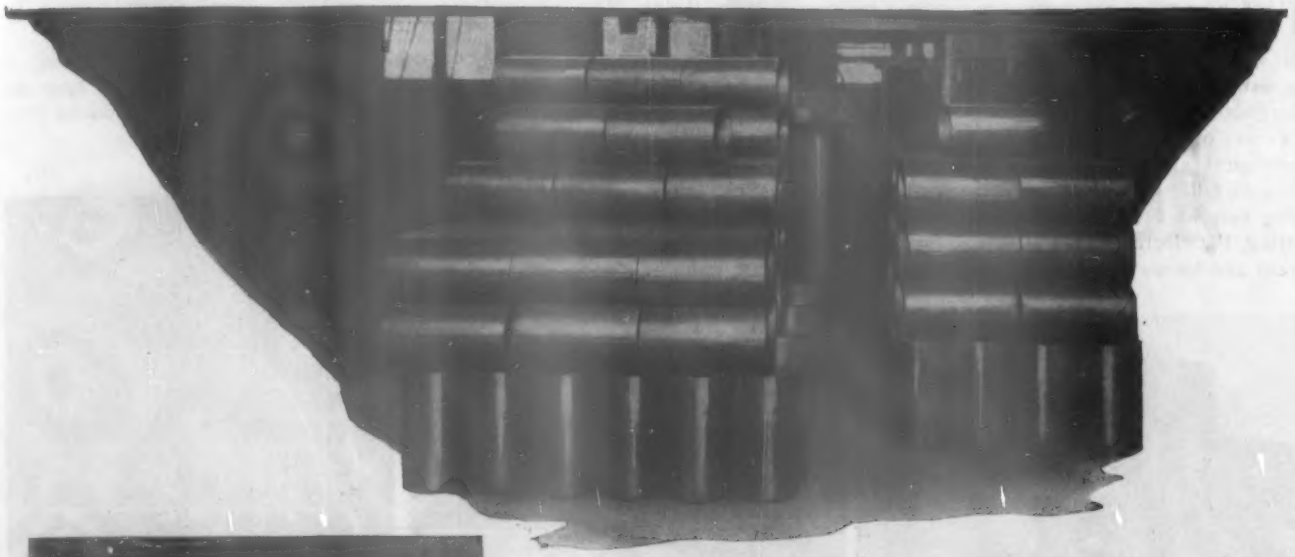
location before being aligned were first partly rammed separately. In the main section, the molding material in the hollow interior was backed by means of a plate wedged against the projecting ribs. The broken parts of the casting were later held in alignment by means of four electrically welded straps. Five heating gates were used, two on each side and one at the end. One pouring gate and four risers were used, requiring 600 lbs. of Thermit. According to latest information received the welded flanging machine had been again installed and in operation. An equally interesting weld was made on the pipe proving machine. In the case of this casting, after the parts were aligned, ramming was executed with the casting first placed in one position and then turned over in another position and the ramming then completed.

WELDING DRIVER SPOKES

Editor:—I have been welding in a railroad roundhouse for some time and find that most of the previous welds on broken driver spokes were failures. I find that you will get better results if you take the tire off and V out the spokes as usual, then heat the rim till the end of the spokes separate about 1/16 of an inch, if there are more than three or four, and one-eighth of an inch in the case of one or two. This is the proper separation when welding with electricity but should be increased a trifle for a gas weld. Weld in the cracks while the torch is still on the rim and this will take care of the expansion.

I have welded as many as nine out of twelve on trailer wheels with perfect success. CLARE G. RICHMOND.

Where Speed Shows Better Results



Straight seam welding of tanks by G-E Automatic Arc Welder.

Building up shaft by G-E Automatic Arc Welder.

Automatic Arc Welding

The above picture shows 50 tanks welded by a G-E Automatic Arc Welder in a half day, as compared to 21 tanks welded by the hand method in a full day. The metal welded is 1/8" thick by 24" long.

Through this automatic application of the electric arc, a steadiness of the electrical conditions in the arc is obtained and maintained, resulting in a uniform and high quality of weld—and higher speed. Higher welding speeds produce lower welding costs.

The principal field for the G-E Automatic Arc Welder is the production, by welding, of duplicate objects in considerable quantities.

Its greatest use is for straight line seam, which is the simplest form of weld—but it also does efficient welding of circular seams, and in building up processes on metal.

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ELECTRIC ARC CUTTING

Graphite or Carbon Electrodes Used—Process Applied to Cutting Risers and Rivets—Economical for Cutting Copper

By A. M. Candy*

THE process of arc cutting is purely a melting process, the heat energy of the arc terminal being directed along the line where the cut is desired. Graphite or carbon electrodes are usually employed for this work although bare metallic electrodes have been used by operating them at current values in excess of those used for welding. This latter scheme is not economical and therefore will not be discussed. In special cases metallic electrodes heavily wrapped with asbestos yarn using current values higher than normal have been used for cutting, the electrodes being first dipped in water which forms steam and blows the molten metal away. This method, however, is also very expensive and has been used only to a limited extent by the British Admiralty for cutting deep, small diameter holes in armor plate.

Fig. 1—3x9 in. Cast Iron Cut Made in Five Minutes.

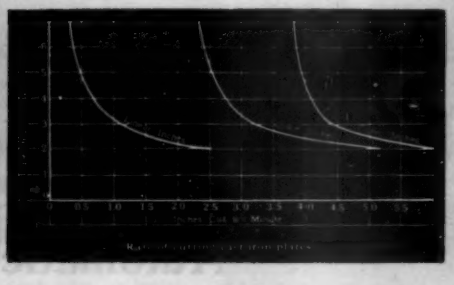

Fig. 2.

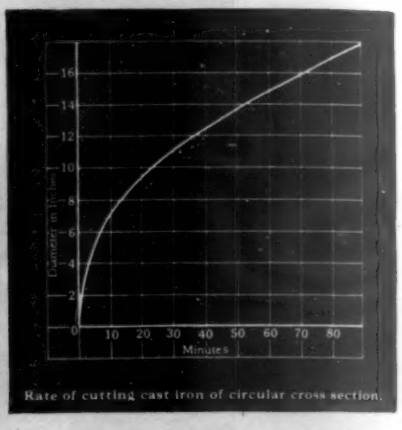

Fig. 3.

For general cutting work graphite or carbon electrodes are used and current values of 300 to 1000 amperes, depending upon the nature of the work and the cutting speed desired.

Foundries make use of arc welding equipment for repairing defective castings and use the same apparatus for cutting off risers and burs from their castings. Fig. 1 shows a riser from a large grey iron casting which was cut through the neck in 5 minutes' time using 800 amperes, the neck measures 3x9 in. Just as a demonstration the riser was then cut through the main portion 8x8 in. in 17 minutes using 800 amperes. With labor at 60 cents an hour and electric power at 2 cents a kilowatt-hour for the motor generator, this would give a cost of 15 cents for cutting neck and 52 cents for cutting body of the riser.

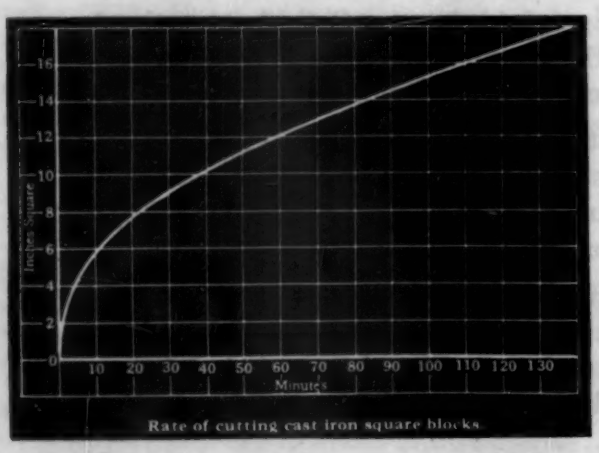

Fig. 4.

Fig. 5—Specimen Cuts on Cast Iron and Steel.

The speed of cutting castings of several forms is shown by Figs. 2, 3 and 4.

Fig. 5 shows two sample cuts. The one at the top, which is cast iron 1½ in. thick, was cut at a rate of 16½ ft. per hour and the one below, steel, 1 in. thick, was cut at the rate of 21½ ft. per hour. Both cuts made using 400 amperes.

Where it is desirable to cut the material to accurate dimensions, it is necessary to lay out a guide line with white lumber crayon which the operator can follow with his arc. It is then possible to make a neat cut in ¼, ⅜ or ½ in. thick plate steel as illus-

*General Engineering Department, Westinghouse Electric & Manufacturing Company.

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trated by Fig. 6. This shows a piece of ¼ in. plate steel cut at the rate of 75 ft. per hour using 450 amperes.

Fig. 7 shows a sample of rivited plate, some of the rivets having been cut off with the arc.

Companies making a practice of scrapping and rebuilding steel freight cars will find the arc process an economical method for

Fig. 6. Cut Made in ¼-Inch Plate Steel.

cutting rivets and for cutting up steel plate material into pieces sufficiently small either to be charged directly into the cupola or to be cut up to such size that the pieces may be handled for recutting in a shear. The plate material in these cases is generally heavily covered with paint or rust so that current values of 400 to 600 amperes are frequently used and, in some instances, as much as 800 amperes. Using this latter current, value cars

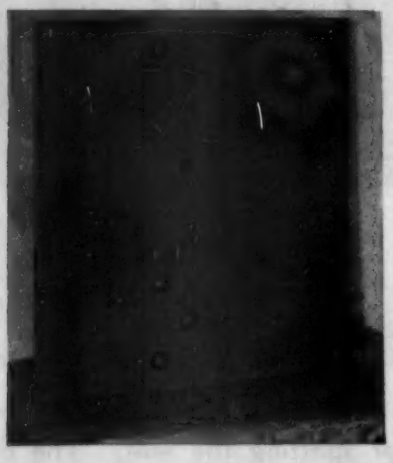

Fig. 7. The Arc Can Be Used to Cut Rivets.

have been cut up at an average rate of 75 ft. per hour, an entire coal car being cut up in four hours' time into pieces sufficiently small to be handled by four men who were shearing the material for cutting into charging size. The cost of the arc cutting including labor and power for the motor generator was $6.80 in this case.

Fig. 8. Arc Cuts in Copper Billets.

For cutting the rivets, currents of 400 or 600 amperes are usually used. When using 400 amperes, average operators will cut from 1,800 to 2,000 rivets, ⅝ in. in diameter, per ten-hour day and some operators will run as high as 2,600 to 3,100 such rivets when the work is on a piece rate basis.

Cutting with the arc is not limited to iron and steel, but can be applied equally well to non-ferrous metals, such as brass, bronze and copper. In fact, for cutting copper, which cannot be cut mechanically, the arc process is a very economical method to use.

Because of the high thermal capacity and high heat conductivity

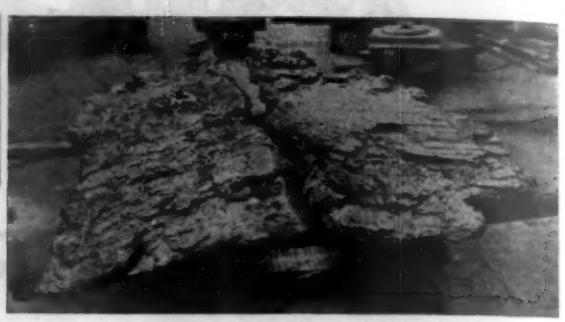

Fig. 9. Copper Slag Cut by the Arc.

of copper it is necessary to concentrate the applied heat at a sufficiently high rate to melt the copper before the heat is dissipated in it. To do this cutting effectively it has been found most satisfactory to use a current value of 800 to 1,000 amperes. Fig. 8 shows two copper billets 4x5 in. which were cut in two as indicated, using 950 amperes, the cutting time being 6½ minutes for one and 7 minutes for the other.

Fig. 9 shows a large piece of copper slag which was originally 6½ ft. wide and 7 ft. long along the central cut. The metal was approximately 1½ in. thick through the sections where the side cuts were made. This was done at the rate of 3½ ft. per hour. The thickness of the metal through the central cut varied from about 1½ in. at the extreme edge to 7 in. at the center of the piece, the average thickness therefore being about 4¼ in. This cut was completed in 5 hours. A current value of 1,000 amperes was used for all this work. The cost of doing the work on the basis of labor at 60 cents an hour and electric power for the motor generator at 3 cents a kilowatt hour is $16.78.

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WAGNER SPEAKS ON WELDING PRACTICE DEVELOPMENT

R. E. Wagner, of the General Electric Co., Pittsfield, Mass., recently spoke on the subject of "Electric Welding Applications, Old and New," before the Metroplitan Section of the American Welding Society at New York City.

Mr. Wagner's lecture was very interesting because of his broad experience in this field and also because he illustrated it so well with slides and motion pictures. He brought out the gradual change in the practice of arc welding, as the carbon electrode was supplemented by the use of a filler rod, and then by the use of the metallic electrode. He then discussed the proper use of electric welding apparatus on different kinds of work, and the testing of welded joints.

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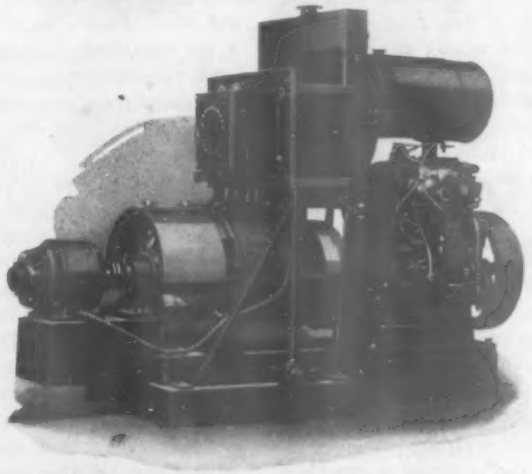

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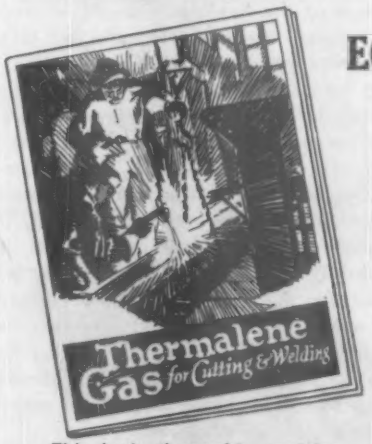

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TRAINING WELDING OPERATORS

Manufacturers Should Not Be Expected to Bear the Whole Burden—Welding Deserves Attention of Educators

Cincinnati, Ohio.

Dear Ed:

I came across a rare lad today; one who is just a wee bit off on how to instruct welders. He doesn't live in this city, but was just passing through. He certainly was a card. I don't know as I ever met anyone connected with the game who was quite so radical in his views. He recalled to my mind that little story they tell about the Scotchman and his friend. The Scotchman complained that all the world was wrong, but his friend and himself, and sometimes he had grave doubts about his friend. That's the way he impressed me, Ed, as if everybody were wrong but himself; but at that there may be some wisdom in his words. I will pass them on to you for what they are worth. Perhaps you will enjoy his viewpoint.

"Every now and then," started my friend, "somebody brings up the subject of training welders. If it is not in the trade papers, it is at some welders' meeting, and what does it all amount to anyway? Are there any constructive ideas outlined? Do any of the principal speakers know anything about the art of teaching? No sir, not one of them. They are all acquainted with the practical side; but they seem to forget that imparting knowledge is just as great an art as the actual doing of the work. It makes a fellow wonder some times how they all manage to pick the wrong tree to bark under. It seems to me that everybody expects the apparatus manufacturer to go ahead and build institutions for the education of welders and bear the whole responsibility; but such an idea is preposterous. Those interested in this subject should ask themselves this question: 'Who benefits the most, the manufacturer or the user?' With this viewpoint in mind the answer to their perplexing problem may become somewhat simplified. We will all agree that the apparatus manufacturer is interested in the application of the process; but from somewhat of a selfish standpoint. Likewise the oxygen and acetylene makers, as well as the carbide producers, and the various firms dealing in the supplies and accessories consumed; they all have a similar interest. I contend, however, that the ones most vitally interested are the users themselves.'

"We all realize that there are a great many welding schools now in operation," he continued, "but look at them! What are they doing? It is the results that count nowadays, and we must confess that these schools are not producing the desired results. Let us see if we can find out the reason. First, let us ask ourselves this question: How do these schools start their welding courses? Realizing that there is a demand for welding instruction, the first thing that is done is the installation of a welding apparatus, and then some chap who has had a little practical experience is hired to do the teaching. They do not seem to appreciate, as I have said before, that the teaching itself is just as much of an art as the actual welding, and there are mighty few welders who have the qualifications of an instructor. What then is the result? In the first place it does not take them long to find that the gases used are very expensive, when used permiscuosly, and therefore only a limited amount is furnished. As a rule the fee charged is very nominal, therefore, the school could ill afford to supply the amount of gas and material to give the student his proper training under the plan they have in mind. The result is that most of the work is performed by the teacher on whatever material happens to come along, and the students are allowed to look on. Now you know, as well as I, how easy (?) it is to learn welding by merely looking on."

"Criticising the school system as generally employed," my friend went on, "how can anyone expect results from the instructors that are usually employed? As a rule the salary paid the teacher will usually indicate his capacity as a welder. If he is a real good welder and knows his subject thoroughly, he certainly is not going to accept a low rate of a teacher, when he can go out any time, and in any place, and draw down a wage two or three times as much. If such is the case, and the instructors are not of the right caliber, is it not reasonable to suppose that more harm than good to the industry results from their efforts."

Seeing that his highness was getting a little wild, Ed, I tried to interrupt him, but it could not be done.

"You may think that I am pretty radical on this subject, but wait until you hear me through," he kept right on going. "Now, if I were king of this vast domain, and had it within my power to offer suggestions on how to increase the supply of good welders in this country of ours, I would set about it in a very systematic manner. There would be no central colleges to grant diplomas decreeing John Smith and Bill Jones master welders. This idea of having an examination board, such as advocated by some people, would certainly never apply to a case of this kind. A man who wants to hire a chauffeur to drive his automobile does not satisfy himself with any diploma from an automobile school, certifying that the applicant is capable of driving a car. Neither should the foreman of a welding department depend upon any credentials of this nature. What he is interested in is not so much what the applicant for a job has done on other classes of work; but what interests him is what results he can produce in this particular job. What I am driving at is this: the welder might be a first-class man on steel work and various other metals, but not so good on cast iron. There is only one way for a man to hire out, and do so intelligently, the way I look at it. A piece of scrap metal should be chosen, the kind that is to be welded. It should be broken and then welded in the same manner as it would be for salvaging. Upon completion of the welding it should be broken right through the weld, and the interior of the weld will be the best credentials that any employer could possibly wish for, to judge the applicant. So as I have said, there would be no diplomas granted, but instead I would summon the leading authorities of the apparatus manufacturers, the gas manufacturers, and those interested in the various other industries supplying material for use by the welding industry; and at that time I would call in men of a similar standing in the educational world. At this convention I would place before them the requirements, and have them solve the problem in the most intelligent manner possible. It would seem to me that this convention, well versed with the practical side of the welding industry, would appreciate that with the proper foundation, both in the theory and practice that a student ought to, and certainly would advance and become a more proficient operator than under the wing of an entirely practical man who lacks all knowledge of theory."

"What are the requirements of a good welder? Everybody knows the answer. He must know first of all how to fuse his metal. In the second place, he must know what penetration means, and how to accomplish it. Third, but by no means least, he must know expansion and contraction and how to make provisions for them. These subjects, treated from an educational standpoint, would appear in a much different light from the practical. An old-time welder may know a method of fusing his metal that gives him first-class results, he may not know why he does it that way; it may be only force of habit. Again, it may be considered as working backward by others, and if he were to try to teach somebody his methods, it would require a great deal of time and patience. As a parallel, let us take, for example, a mathematic formula. To start with we imagine that if called upon to determine how much three times four are, that the ancients counted out four stones, and put them in a pile; counted out four

(Continued on page 46)

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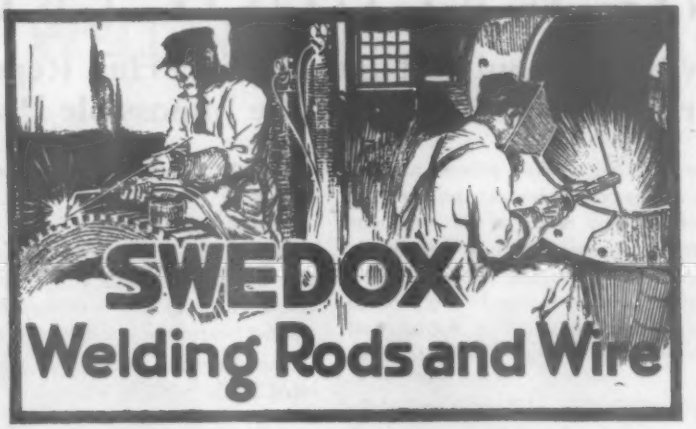

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SOLVING WELDING PROBLEMS*

How the Ingenuity of the Welder Has Repeatedly Overcome What Seemed to Be Impossible Problems

ALL of us who are interested in the welding process and the use of the cutting torch frequently encounter problems in application. We know that in the past many of the problems have seemed to be so serious that no real attempts were made to overcome them and the process was, therefore, not used.

As members of this association we have a moral obligation to study how to overcome obstacles and we must not be instrumental in rejecting the processes without doing all that we can to solve the problems.

Unaided, however, each one is limited in ability to undertake work, and the question is where to go for help. My answer is to consult an engineer specializing in process work. Should the first man consulted not be able to solve the problem, it would be well to consult others—calling upon those who have as broad a process experience as possible.

There are many ways in which problems may arise in an industry—some of them may be operative; some may be in the nature of routine business, such as estimating costs or planning work; others may involve highly technical details such as the composition of metals. But it is safe to say that an engineer who is thoroughly experienced in welding and cutting matters will be able to correctly direct the work or to call on additional advisers until the proper authorities have been consulted and the answer formulated.

It may be well to illustrate how certain problems have been handled. I will first take the case of welding submarine mines, which was undertaken as a very secret piece of work in the early days of the war. Oxy-acetylene welding was found to make a thoroughly tight joint, but the light gauge metal warped to such an extent that the finished product was not considered satisfactory. Due to this condition of finished product, which was mostly one of appearance, the oxy-acetylene welding process was abandoned in favor of the electric welding process, but as the metal was of a very light gauge it was found difficult to make the electric welds tight to sea water, a highly important factor.

About this time engineers who had considerable experience in welding problems were called in and jigs were developed which held the sheet metal so rigidly that warpage could not occur when the oxy-acetylene process was used. This resulted in the making of a thoroughly satisfactory weld for tightness and gave a symmetrical mine.

Before welding was tried on these containers, the submarine mine was made of two sections having rolled edges which fitted on to a rubber gasket. Clamps were placed over the rolled-up edges every few inches and these were then screwed tight so that the rubber would be properly compressed and theoretically water-tight. It was found, however, that these mines were seldom tight, particularly in that tightness meant that not even a drop of salt water should enter the mine over a period of six months. Solving the problems of making the mines water-tight by the use of welding and overcoming warping of the sheet metal under the welding torch were extremely important steps for welding, and are among those which have been most impressive to the student of welding since the problems were correctly solved.

Now, after working out such problems, the engineers and operators who gained experience at that time were naturally in position to help on many other problems connected with proper handling of light gauge metal to prevent warping, etc., and the experience gained has been decidedly beneficial to all of us, because numerous other things are now done by welding that have grown out of the fact that welding engineers knew how to make essential jigs.

Another problem with which practically all of us are familiar is the welding of pressure vessels. It is interesting to see how this is being handled at the present time, because the final decision with regard to welding of pressure vessels will have a very distinct bearing on the advance of the entire welding industry.

The American Society of Mechanical Engineers became interested in the welding of unfired pressure vessels because the Society years ago had found it advantageous to get up a boiler code for the benefit of its members. As an outgrowth of the boiler code it was found desirable to get up a code for unfired pressure vessels. Codes of this kind are intended for one purpose only—specifying safe practices with regard to construction and safety devices to prevent applying excessive pressures to the vessels. A good many states have adopted the A. S. M. E. boiler code and the inspectors of boilers and pressure vessels in these states are, therefore, plainly interested in all of this new code work.

Due to the failure of welded pressure vessels in several instance, state inspectors wished to safeguard life and property in their respective states by forbidding the use of welding on such pressure vessels. This would have been a serious blow to the welding industry, so it became a problem for the entire industry. It is being handled at the present time in a way which gives promise that a satisfactory solution will soon be reached, and it is to be noted that the welding engineers have been called in to help solve the problem.

It would be more difficult to handle problems of this nature if the companies selling welding equipment and supplies for welding were the only interested parties; but the manufacturers of pressure vessels have had so much experience with the welding processes that they are also back of the investigation work, even to the extent of contributing time and money to it. A committee of tank manufacturers was organized to work on this problem because it was one of such wide scope that it affected a great many organizations. Seven members of this committee contributed three welded pressure vessels, all of which were turned over to the Bureau of Standards for test as agreed upon with the personnel of the Special Committee of the A. S. M. E.

In addition to this test a committee of the American Welding Society offered to co-operate in the work, and many of the specifications of the American Welding Society, such as the composition of proper welding rods, have been incorporated into the tentative code and utilized in the welding on the test tanks.

Furthermore, many engineers who have been devoting a great deal of time to welding work, advised the committee of the A. S. M. E. with regard to test methods, until tests which it is believed will safeguard the user have been developed and are being used as the basis of testing the cylinders now in the hands of the Bureau of Standards. These tests which have been agreed upon resulted from observation of similar problems in various other industries; in other words the engineers were not in this case developing anything radically new, but were applying to the problem in one field the knowledge obtained in others.

The above history with reference to the problem of pressure vessels indicates the depth to which some problems may go, but even in the above I have not talked about the weldability of steel, or trying the proposed use of double "V" bevels on all edges of longitudinal seams on Class A tanks, or the design of tanks having heads concave to the pressure, etc., all of which points are having a very material bearing on the solution of the major problem, and which have been the outgrowth of constant study by the process engineers.

**Paper read before American Welding Society, Philadelphia, January 15, 1923.*

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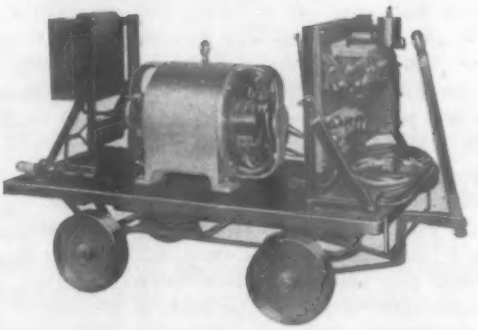

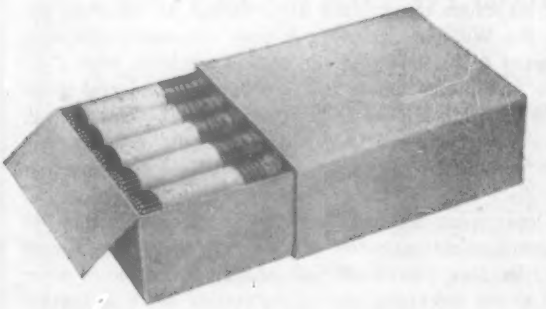

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When the test results have been published and the pressure vessel code has been established, we will have information which should be of great aid to one having similar problems with regard to the strength of, say, a pipe line weld. The welding engineers who have been working so faithfully on the problem will have, also a valuable experience to assist them in applying the information thus obtained to new problems. With the growth of welding and pipe work who of us can fail to believe that we will not be swamped with scores of questions with regard to all types of welded pipe construction?

There are numerous other types of problems which affect the members of the Welding Society. A very common problem is that with regard to the effect of the cutting torch on steel.

One of the first places where this problem attained real magnitude was in the Philadelphia District where, at the Navy Yard, turbine rotors were being cut from billets with the oxy-acetylene cutting torch at a great saving in expense over machining, but some of the discs showed cracks after the cutting operation and the Navy Department seriously considered forbidding the use of the oxy-acetylene cutting torch. Oxy-acetylene engineers were consulted by the Navy Yard officials and these engineers were able to point to the successful use of the cutting torch in several forge plants which were using the process for shaping up crankshafts, connecting rods, etc., for assembly in heavy machinery requiring material of the very best construction. This lead deeply interested the officials of the Navy Department, who finally developed a procedure which has put the seal of approval on oxy-acetylene cutting, yet has safeguarded the operation by having the finished rotors annealed to relieve old strains.

It is safe to say that a gray iron casting which is broken or has sand-holes may be welded so as to have 100 per cent of its original strength, provided it is properly preheated before the welding operation and is annealed thereafter. This is a broad statement which all of us should keep in mind. On the other hand we all know that thousands of broken gray iron castings are being thrown in the scrap heap every day, necessitating expensive replacement. It may be that the local job welder has not impressed the owner of the casting with his ability to weld it, or it may be that the owner has had an experience with welding when correct preheating or annealing method was not followed, resulting in the repair being a failure; but what ever the reason, if anyone scraps a broken iron casting from now on it is because he does not call in an oxy-acetylene welding engineer to show him how the work can correctly be done. I have purposely in this case said the *oxy-acetylene engineer*, because gray iron is not being entirely successfully welded by the electric arc process as yet, although that process application is now being studied by several large organizations.

On the business side we also have problems, such as how to estimate this cost for given work; what kind of tests to put on finished welds and, here again, the advice of engineers should be sought, because practically all who have submitted such problems have received satisfactory answers, with the result that the welding process is now being used in many places where it would not have been used if it had not been found possible to make satisfactory estimates and tests.

Some cases have recently come to hand in which the estimates of pipe welding costs have varied greatly. When the job is handled in one way, an estimate of, say, 70c will be given for the cost of an 8-inch welded joint, and $2.00 a joint when an entirely different method of handling work is involved. This difference is a very serious one, amounting to almost 3 to 1, it is therefore, a real problem to all of us. Let us analyze this and see what additional information should be furnished so that we may know why the low cost is given in some cases and the higher cost in other cases.

We will take for example the 70c figure. This is based on the actual welding labor, oxygen, acetylene and welding rod used in making one joint, basing the cost on gas delivered at, say, a fabricating shop such as might be found in one of the big pipe mills. A contractor who was laying a pipe line and used this 70c figure as the cost of making a joint would be laying himself open to serious loss, because, first, his labor costs are more, due to the fact that the men have to be transported to and many times fed on the job, the gases have to be hauled out to the work, and in addition to the actual welding we can figure in the labor required for handling the pipe. On this basis the cost will be about $2.00 a joint on a well-managed job. In between these two costs we find that of pipe welding in industrial centers, but where the work is done at some distance from a welding shop or central station. The labor costs will be the same for the actual welding as in the shop because local labor can be used. The gases will also be at a delivered price for the locality, no additional costs being required for distributing. But considerable extra help will be necessary for handling the pipe and this must be taken into consideration and so would make the cost, say, $1.25 or $1.50 per joint.

Calculation of costs does not stop, however, with the submitting of estimates of this kind. We find that the person who is requesting the information probably has never considered the cost of making a joint with a screw connection. Any fair comparison of costs must take account of these factors as on big installations a considerable saving can be made in the cost of pipe by using plain-end instead of threaded pipe; a lighter-weight pipe can often be used, because there is no reduction in strength due to the threading; 40-foot lengths of pipe can be used on pipe line projects where welded joints are made, whereas 20-foot lengths of pipe are used with the pipe laying machines; and many other items enter into the problem which almost anyone can think of if he but faces the issue. In addition to the above points we must consider that the cost of cutting off pipe with the ordinary mechanical cutting tool is a very heavy expense; then special vises and threading machines are required for threading the short lengths of pipe, which is seldom estimated in the cost of making the screwed joint. Our problem has, therefore, resolved itself into what does it actually cost to make a completed pipe system with the oxy-acetylene process and what are the comparative costs with the older method of threading or coupling?

On top of the economic factor is, of course, the quality of the joint, and it is quite certain that all interested in the subject are convinced that the welded joint is much better than any other type of joint used in pipe work.

Another example of a problem which involves estimating is that which many have faced within the past year or two with regard to the cutting of steel in the scrapping of ships. It does not do to simply take a cutting cost table and say that this ought to be the cost of doing the job, because the cutting tables are primarily based on steady use of the torch under shop conditions.

How does practice check with theory? As in the case of estimating the cost of welding a pipe line, we must consider among other things how much additional labor is required to do the entire job; how much of the job should be done with oxy-acetylene, and how much with the shears, etc.?

There are men in the country who have had a good deal of experience with cutting, men who have worked out these problems so that they are on a pretty sound basis. It is from these men that the information should come, because it is based on actual accomplishment and gives inclusive costs.

The engineers who are interested in oxy-acetylene cutting have had many problems of this nature put to them. One of the most interesting pertains to the cutting up of old railroad cars, wherein the contractor found that his costs were running very high and that his estimate for the contract was away out of line, yet his estimate had been made after consulting with an engineer who had quite exact information as to what the costs should be.

The contractor challenged the estimate which had been made as a result of the figures being obtained by him in practice, so an engineer was asked to study the actual work in operation for a few days and report on the work then in progress. He found that the operators were cutting as they found the work, taking

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Freedom from flash-backs—regardless of the size of the welding or cutting job, — gases properly mixed *beyond* heat radius of the work.

Positive safety, whereby any attempted flame propagation into the welding or cutting torch is expelled.

Consider also that TORCHWELD welding torches are machined from solid bar brass stock, and that principal parts of the cutting torches are similarly made; all permanent joints are brazed. Heavy duty welding tips are machined from solid bar copper stock, and are sufficiently heavy to make them sturdy, long wearing, and free from seating troubles. TORCHWELD torches are as well balanced as the beam on a scale; they do not tire the operator.

A comparison of qualities and prices will reveal values you will eventually require and demand in torches, regulators, and general welding and cutting equipment.

Buy Torchweld Now!

Torchweld Equipment Company
Fulton and Carpenter Sts., Chicago, Ill.

"RACO"

MILD STEEL ELECTRODES for ELECTRIC WELDING

A general purpose wire, guaranteed to conform with the following specifications:

Penna. R. R.	Specification No. 156A
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Also furnished dead soft annealed.

"RACO" COVERED ELECTRODES FOR ELECTRIC WELDING

"RACO" Covered Electrodes are used with either alternating or direct current where bare wires will not give satisfactory results.

"RACO" IRON ELECTRODES FOR ELECTRIC WELDING

This wire may be used with success wherever imported Norwegian or Swedish wire has been considered necessary.

"RACO" MILD STEEL RODS FOR OXY-ACETYLENE WELDING
Copper Coated

Answers the usual railroad, shipyard and industrial requirements as are allowed by authoritative regulating bodies such as the American Bureau of Shipping, the Interstate Commerce Commission, etc.

Blue Label

Colored labels in this style identify each different kind of RACO WIRE

Samples for testing and descriptive booklet sent promptly

REID-AVERY COMPANY
21st Street and Washington Avenue
Philadelphia, Pa.

everything as it came. This included the very light-gauge metal on the sides of the cars and the heavy angles and reinforcing plates. He also found that the operators were quite unskilled, because the contractor believed that anyone could be taught to use a torch efficiently in a few days, and he could get inexperienced men at a much lower price than he would have to pay experienced cutters.

The engineer then convinced the contractor that a good cutter is a skilled workman and that the quantity of gas used by him in the course of a day is worth two or three times his pay, and therefore, a man who can get the best out of the gases is worthy of his hire.

The contractor with the engineer's assistance then studied the problem from a managerial point of view and worked out the details of the cutting job so that skilled operators would cut first the line sections, using a minimum quantity of gas which would be sufficient on that type of plate, then going back over the heavy sections of the skeleton of the car, cutting them with a larger tip and the necessary gas pressures. In order to interest the men in their work he assigned a certain quantity of oxygen and acetylene for each unit of work and set up a basis of sharing in any savings of gas with the operator, but penalizing the operator if he used an excessive amount.

This study of the car cutting costs results in the contractor easily meeting the estimates which had been made as to the maximum for the job and, needless to say, the contractor was quite pleased.

It is certainly to be hoped that we will not find in a few years from now that present day users of the process have abandoned an application on account of minor difficulties when, by calling in engineers, the user would have received the necessary help and the problem have been classed among those solved to the satisfaction of all. We know that this has too often been the experience in the past and it is up to us to make sure that it does not occur in the future.

MILLER SPEAKS AT WELDING SOCIETY MEETING

S. W. Miller, of the Union Carbide & Carbon Research Laboratory, spoke on "Welding of Unfired Pressure Vessels" before the Metropolitan Section of the American Welding Society, at the Engineering Societies Building, New York City, March 20th. He discussed the code that is being tentatively adopted by the government regarding the welding of unfired pressure vessels. The code has three specific points, namely, that only double-V welds will be allowed, that all restrictions regarding the contents, pressure and uses of the vessels are taken off and that a standard test must be performed on the welded section. The test consists of running the pressure up to 1½ times the working pressure and then increasing the pressure to 3 times the working pressure and holding it there for 3 minutes. A complete report of this will be published in the next issue of the Journal of the American Welding Society.

C. J. Holslag, of the Electric Arc Cutting & Welding Co., spoke of the rapid advances made in welding thin section of cast iron by electric arc methods during the past two years. The point was emphasized that no fear should be had in performing work of this kind under proper supervision.

The Bender Welding Co., Mobile, Ala., is planning to rebuild the part of its machine and welding works which were recently destroyed by fire.

Plans for the construction of a new $125,000 plant have been recently announced by the Linde Air Products Company. The new plant will be built at Savannah, Ga., and the work will start in June. They expect to have the plant finished by December.

The Seamless Steel Products Co., Milwaukee, is preparing to rebuild its works at Twenty-seventh and Greves Streets. A fire ruined considerable of the equipment beyond salvage and the damage amounted to about $125,000. The company specialized in acetylene gas tanks for welding and cutting units, and has orders requiring capacity operation for an indefinite period. E. J. Lansing is president and general manager.

The Oldman Boiler Works, Buffalo, and the Marine Welding Company, same city, have been consolidated by the Oldman-Magee Boiler Works, Inc. The latter company has incorporated for $300,000 and is headed by E. W. Oldman, M. S. Oldman and C. D. Magee. They will continue at the present plant, 28 Illinois Street, and expand the works for manufacturing engines, boilers and other products of a similar nature.

TRAINING WELDERS

(Continued from page 40)

more and followed them by another four and continued this practice until some one discovered the multiplication table, and after that they had a short-cut. Would it not be reasonable to suppose that at a convention, such as I have outlined, that the educational men working hand in hand with those higher up in this industry of ours, would get right down to the bottom of things, and formulate the best procedures for the proper training of students. A procedure for instruction could then be set up as a standard and distributed to all the schools and colleges throughout the land, giving them a definite and accurate means on which to base their welding instruction. The cost of such a procedure would be trivial in comparison to the results produced, and would certainly be the greatest boom that could possibly happen to all those concerned with the future of the welding industry."

I will have to ring off now Ed because I have to catch a midnight train; but you got the highlights anyway, and I will be looking forward to hear what you think of them.

With kindest regards, I remain

Just as before

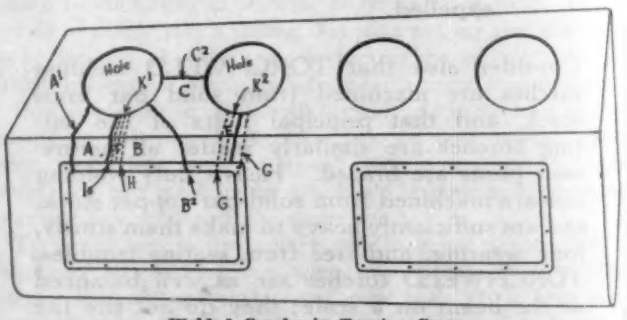
Shep.

WELDING A 300-LB. TRACTOR CASE

By Stillman Peck

I welded a large cast iron 75 H. P. Holt Tractor Case that was broken in three pieces, A, B and C, as in diagram, without preheating and it had now been in service for the past sixteen months.

The first welds were made at A1, C2 and B3, there being free ends for contractions at I for A and B and G for piece C. I



Welded Cracks in Tractor Case.

then welded four pieces of steel at points J and G, also at I and H, first cutting out the necessary amount of space from the castings. F and E are the pieces of steel welded at I and H and J and G, and this left me two welds through the center of E and F (which were the steel pieces) we will call K. This was all done with the torch and required no preheating. The problem was how to get the points together and I did this by welding the two points K1 and K2 which were steel with the electric arc and as I was welding from steel to steel at these two points, and taking plenty of time, I had no trouble. This job proved satisfactory and is giving good service. The case was entirely too large to preheat and keep from warping, as it weighed in the neighborhood of 300 lbs.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

Acetylene Cylinders Bought and Sold—I can save you money on the purchase of Prest-O-Lites and other acetylene cylinders or will help you if have any to dispose of. Robt. B. Dyar, 140 S. Dearborn St., Chicago, Ill. t.f.

SALES AGENTS

Territory open for aggressive agents to sell Milburn Welding and Cutting apparatus, the product of 20 years' specialized development and manufacturing experience in the acetylene industry. Supported by trade journal advertising and intensive mail campaign. Stocks carried in principal cities. Highest quality of apparatus, Milburn guarantee.

Preference given to men with welding experience or firm with welding trade. Write in full confidence regarding territory desired and your facilities for handling it.

THE ALEXANDER MILBURN COMPANY,
1416-1428 W. Baltimore St., Baltimore, Md.

Position Wanted—First-class electric welder with two years' experience on railroad work, desires permanent position. Perfectly capable of doing all classes of railroad welding. Address 73, care The Welding Engineer.

Position Wanted—Man capable of taking camplete charge and building up the business of a first-class welding shop or department, and who is thoroughly competent in Oxy-Acetylene and Electric Arc Welding, wishes to make permanent connections with a well-established company, preferably located in the east. Address 74, care The Welding Engineer.

For Sale—2-man Oxy-Acetylene welding shop in a growing, prosperous city near San Francisco, Cal. This shop is fully equipped with first-class outfits and it also has a service car equipped for quick work on outside jobs. Address 75, care The Welding Engineer.

For Sale—Lincoln 200 ampere arc welder with two-phase 220-volt motor attached. Price $600.00. Lincoln 200 amp. arc welder with 3 phase 220 or 440-volt motor attached. Price $650.00. C. & C. 200 amp. double arc welder with 15 H. P. 220-volt D. C. motor. All self contained with switchboard and stabilizers. Price $850.00. Address The Industrial Electric Company, 5230 St. Clair Avenue, Cleveland, Ohio.

Wanted—First-class electric welders, steel plate, indoor work, steady employment the year around. Address General Boilers Company, Waukegan, Ill. 2t.—Ap.M.

Wanted—International Oxygen Company, Newark, N. J., has position open for first-class salesman. Only men with experience and well recommended need apply. Address Box 288, Newark, N. J.

Wanted—Experienced oxy-acetylene welder, all-round work by manufacturer of kerosene oil burning torches, furnaces, forges and pre-heating tables. Prefer man experienced in assembling bench work, testing kerosene and fuel oil preheaters. Write fully, giving age and experience. Address H. H. Kress, 1718 Sansom Street, Philadelphia, Pa.

Westinghouse
manufactures complete arc welding equipment for all welding and cutting purposes. Write for Leaflet 1826-B which describes this equipment in detail.
Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.

CHICAGO SECTION ENJOYS WELDING FILM

At the meeting of the American Welding Society, Chicago Section, held April 6, the program consisted of six reels of motion pictures of welding and cutting operations, taken in the plant of Messer & Co., Frankfort, Germany, and furnished to the Chicago Section for this meeting by Mr. M. K. Dunham, of Chicago. The pictures gave a general indication of the electric and thermit welding processes, then showed the development of equipment for gas welding, starting with the manufacture of carbide, the generation of actylene, the production of oxygen by both processes, and the uniting of these two gases to produce the welding flame. The apparatus for the production of oxygen by the air liquefaction process was shown in operation. This was followed by sectional views of various types of acetylene generators and of welding and cutting torches. The welding operations included the welding of vertical seams, straightening buckled sheets, repairing switches, building up rail crossings, boiler welding, copper welding, cast iron welding, steel cutting, rivet cutting, testing welds, and a series of views showing the usefulness of the cutting torch on a large scale in the work of dismantling a modern warship.

HEYLANDT DIRECTOR ON AMERICAN TOUR

It is reported that Mr. Max Brunn, managing director of the Heylandt Company, Germany, will arrive at New York on April 26, when he plans to make a series of visits to American indusdustrial centers, particularly those plants where Heylandt air liquefaction oxygen plants have been installed. While in this country Mr. Brunn can be reached through his representative, Mr. H. G. Amling, Maywood, Ill.

SMITHOGRAMS—A NEW HOUSE ORGAN

An interesting little house organ has recently been started by Smith's Inventions, Minneapolis, under the title "Smithograms." At present it is confined to a single sheet about letterhead size, but from the first issue it has growing possibilities. The March issue gives an excellent illustrated article on the procedure to be followed in preheating a cracked cylinder head.

The Burke Electric Co., Erie, Pa., has just issued Bulletin 127 showing various welding machines and equipment, and the jobs that they have done.

The Gas Products Company, Columbus, Ohio, announces the completion of the installation of two new air liquefaction oxygen plants, with a producing capacity 400 per cent greater than their old plant. An adequate number of new oxygen cylinders have been placed in service. Announcement is also made of an increase in oxygen gas production amounting to 150 per cent of the former capacity.

The Metal & Thermit Corporation has recently appointed Mr. Charles F. Lederer as general supervisor of rail welding, to assume entire charge of all technical work in the field. A corps of rail welding supervisors will also be organized in connection with the various branches of the company to instruct rail welding men.

No one is better qualified than Mr. Lederer for this new position and his long and practical experience in street railway track work has fitted him to advise not only on the welding matters, but on other phases of track construction and reconstruction. Mr. Lederer has been connected with the Rail Welding Department of the Metal & Thermit Corporation for over two and a half years, and was formerly superintendent of way of the Milwaukee Electric Railway & Light Company, Milwaukee, Wis.

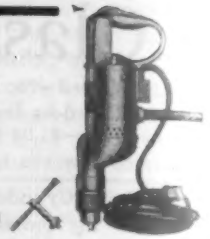
The Coast Welding & Machine Shop, San Pedro, California, has obtained property near the Los Angeles Shipbuilding & Dry Dock Co. They plan to build a machine works to cost $45,000 including equipment.

Learn convenience with a WODACK

WODACK Portable Electric Drills and Grinders are distinctly convenience tools. They make scores of hard jobs easy. They save hours of time that are usually wasted in the handling of material. They get the work done quickly.

Every welding shop should be supplied with WODACK tools. "Electric Drill Facts" will give you full information. Send for your copy.

WODACK ELECTRIC TOOL CORPORATION, 43 S. Jefferson St., Chicago, Ill.



Current Welding Literature

FLASH WELDING, by A. L. DeLeeuw—Advantages of flash welding over slow butt welding. Current consumption and pressure required. Limitations of flash welding. Preheating in flash welding. Hot flash welding. Welding non-ferrous metals.—American Machinist, March 22nd.

AUTOGENOUS WELDING IN THE PETROLEUM INDUSTRY, by K. V. King—Welding has become important to this industry through slow development. The first consideration in welding products should be the welders themselves. Next in importance comes the material to be welded. Hammering is used to improve the structures of the welded metal. It is good practice to anneal acetylene welds. The annealing temperature is a little over 1600° F. Annealed welds show a greater elongation when tested.—American Machinist, March 29th.

PRACTICAL POINTS IN RAILROAD SHOP WELDING, by E. S. Eldridge—Instruction and diagrams for welding locomotive frames with the electric arc and with the torch. Repairing cast iron gears with bronze. Procedure to be followed in welding fire box sheets with the arc. Welding spokes to engine wheel.—Journal of the A. W. S., March.

GRAPHITE WELDING ELECTRODES, by S. L. Walworth—Graphite electrodes are becoming increasingly popular. The method of manufacture produces a practically pure graphite. These electrodes are not subject to breaking and cracking, and are claimed to produce a softer weld because less carbon is carried into the weld. It is also stated that a steady arc can be maintained.—Journal of the A. W. S., March.

SELECTING WELDERS, by S. W. Miller—Much stress is laid upon the importance of previous experience when a welder applies for a job. His ability to set up and get action is another important indication of his proficiency. A probationary period of two weeks is given to allow the applicant to demonstrate his ability.—Journal of the A. W. S., March.

MODERNIZED PIPE CUTTING, by F. C. Fetherston—Manufacturers of equipment built entirely of pipe, fabricate special units from stock lengths of new pipe and odd lengths of reclaimed pipe. A set of patterns is kept on hand so that new pieces can be quickly cut to shape. Most of the cutting is done in a central shop.—Journal of the A. W. S., March.

INVESTIGATION OF THE EFFECT OF TORCH CUTTING FORGED STEEL, by J. R. Dawson—Structural changes resulting from cutting. Normalizing of torch cut forging. Torch cutting red hot steel. Discussions of methods of torch cutting of forgings. Journal of the A. W. S., March.

WELDING THIN SECTIONS IN CAST IRON, by C. J. Holslag—The two cast iron edges must be joined by a band of deposited steel. This must be applied to both edges equally and in small amounts. In some cases the edges of the crack can be drawn together by welding rows of crossed beads at right angles to the crack. When pin-holes or leaks develop an internal or external filler can be used. The nickel electrode has made it possible to produce soft welds on cast iron, but it should not be used too freely.—Journal of the A. W. S., March.

WELDING IN SOUTHERN PACIFIC SHOPS, by H. J. McCracken and F. J. Hickey—The applications of oxy-acetylene and electric arc welding in the tube shop, boiler shop, machine shop and the steel foundry with illustrations of a number of typical repairs.—Railway Purchases & Stores, April.

THE CRYSTALLIZATION OF METALS, by E. A. Atkins—A series of micro photographs showing the effect of heat and cold on mild steel. An investigation shows that the principles which apply to large masses of metal do not necessarily apply in the case of thin wires. It is possible to obtain a wide range of physical properties in one kind of steel in variations of heat treatment.—Acetylene & Welding Journal, London, March.

APPLICATIONS OF THE OXY-ACETYLENE TORCH TO THE CUTTING OF CAST IRON, by A. S. Kinsey—Scrapping locomotive cylinders. Removing cylinder bushings. Scrapping, propelling. Removing gates and risers. Repairing cast iron vessels. Altering machine bases. Cutting cast iron pipe. Beveling for welds. Economy of cast iron cutting. How to cut cast iron. Effects of oxy-acetylene cutting on cast iron.—Acetylene Journal, April.

SAFETY IN COMPRESSION OF GASES, by A. D. Risteen—Air, oxygen, hydrogen, acetylene and other common gases used in the industry present hazards when placed under pressures. Safe practices are described.—Acetylene Journal, April.

PRODUCTION WELDING ON OIL STORAGE SYSTEMS—Methods employed in the plant of a manufacturer of oil and gasoline storage systems. Oxy-acetylene welding is used in the production of tanks, ranging in capacity from one gallon to one thousand gallons. Welding reduced the production cost 40% on one line of products.—Oxy-Acetylene Tips, March.

OXY-ACETYLENE HEATING IN THE GARAGE AND JOB SHOP—Illustrating the value of the oxy-acetylene torch for straightening bent car or truck frames. From the owners' standpoint the saving in time is the most important consideration. Straightening bent parts always requires careful alignment. Job welding shops should become proficient in this application of the torch.—Oxy-Acetylene Tips, March.

PROTECTING THE VISION OF WELDERS—The selection of the right type of goggles or spectacles is of great importance. Nine different kinds of protecting glasses are shown, and the advantages of each type pointed out.—Revue de La Soudure Autogene, Paris, February.

SCRAPPING STEEL CARS BY THE MEANS OF THE CARBON ARC, by E. H. Dralle—Electric cutting process proves an economical way of reducing scrap which can be cut in shears. Various methods of dismantling. Scrapping by cutting through sheets and frame. Equipment required for electric cutting.—Railway Electrical Engineer, March.

WELDING, CUTTING AND BRAZING PRACTICE, by David Baxter—The procedure for welding aluminum sheets. Sample welds showing the results of cutting and poor practice.—American Garage & Auto Dealer, March.

The Mine & Smelter Supply Co., with branches in Denver, Salt Lake City and El Paso, have taken over the exclusive representation for the Wilson Plastic Arc Welder and the Wilson Welding Metals for the States of Colorado, Utah, Nevada, Wyoming, New Mexico and West Mexico. This company will carry in stock, at each of their branches, a complete supply of all grades of welding machines and welding metal for distribution throughout their territory.

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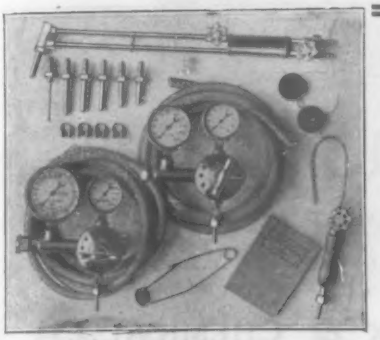

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1 Carbon Removing Torch	1.50	1 Length of 5-ply Acetylene Hose, 12½ ft.	1.50
1 Safety Torch Lighter	.50	4 Hose Clamps	.20
1 No. 30 Safety Front Oxygen Regulator with one 3,000-lb. Gauge, registering cu. ft. and one 300-lb. Gauge	24.00	1 Pair Welding Goggles	.50
1 No. 25 Acetylene Regulator, equipped with one 300-lb. Gauge and one 50-lb. Gauge	18.00	1 Instruction Book	1.00
		1 Adapter	1.50
		2 Cast Iron Rods, 1 Pound Cast Iron Flux; 3 Brass Rods, 1 Pound Brass Flux; 2 Aluminum Rods, 1 Pound Aluminum Flux; 10 Steel Rods	3.00
		Price of Outfit No. 2	$69.20
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For aligning broken sections, whether large or small, the usual shimming process may be forgotten and much time saved by using this compound as a cushion for the work. It can be used in hundreds of different ways, over and over again—it don't wear out. The wide-awake welder will appreciate its true worth.

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For the Oxy-Acetylene Welder

If you are selling welders' supplies, keep a few welding rod holders in stock. There is a growing demand for this handy tool.
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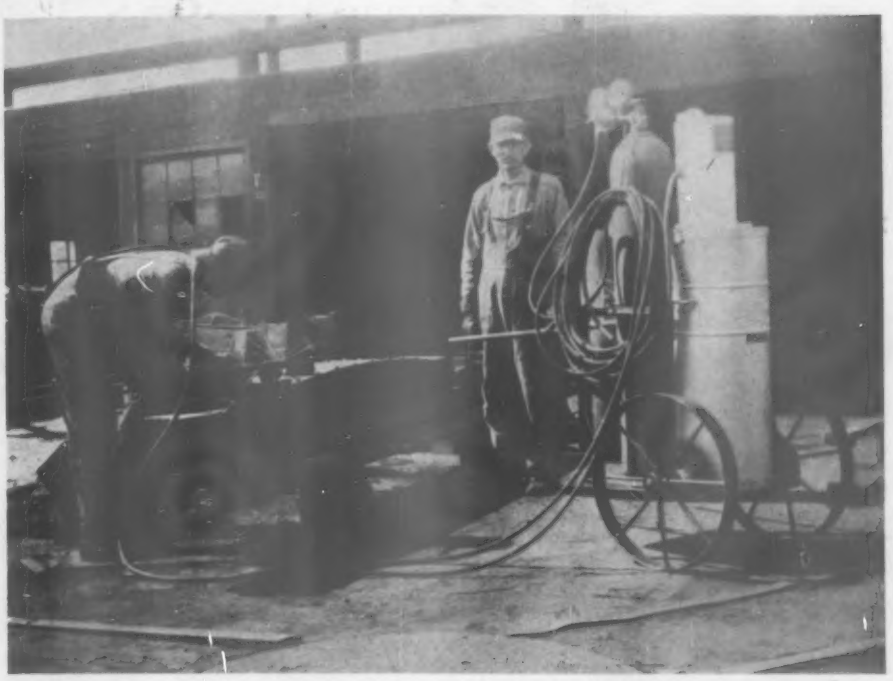
30 Church St., New York, N. Y.

Safe, Portable, Acetylene at a Lower Cost



Make your gas "on the job"

Let the CARBIC system solve your gas problem

A COMBINED ease of handling, a convenience, a safety and an economy not otherwise obtainable—that's the Carbic System.

Fully charged, the generator weighs but two hundred pounds—real portability,—and yet it will take care of jobs both large and small.

Carbic generators have gone through fires—they've been tipped over—tested to the limit in every way and have proven **absolutely safe under all conditions.** Listed as standard by Fire Underwriters' Laboratories.

Less than a cubic foot of stored acetylene in the Carbic generator at any time—another safety feature.

Acetylene by the Carbic System costs less than half as much as compressed acteylene.

Why wait until you run out of gas or get your next acetylene bill to adopt the Carbic System?—Do it now—Insure your gas supply and cut your costs.

The Carbic line is complete, including torches, regulators and all other necessary apparatus and supplies.

Carbic Manufacturing Co.

Duluth, Minnesota

NEW YORK, 141 Centre Street — **CHICAGO, 565 W. Washington Street**

BOSTON, 27 School Street

The Hendrie & Bolthoff Mfg. & Supply Co. Denver, Colo.

Woodward, Wight & Co., Ltd. New Orleans, La.

Representatives and Stocks in all Principal Cities

THE Carbic SYSTEM

These are Carbic cakes; high quality carbide compressed into this convenient form for use in the Carbic generator. Each cake will produce 10 cu. ft. of pure acteylene.

(Approximating (1-3 actual size)

Trade **Carbolite** Mark

A ONE BRAND, HIGHEST QUALITY

CALCIUM CARBIDE

The trade name Carbolite has represented our product continuously for many years. Its appearance on each package is a guarantee of its excellence and a protection to our customers.

Carbolite is carefully manufactured from best grade raw materials insuring at all times a superior quality, both in purity and gas yield. Our modern screening and inspection system also makes certain a thoroughly clean product, uniform in size.

Carbolite is made in all standard sizes and can be supplied promptly from warehouse stocks.

Packed only in Yellow Containers

American Carbolite Sales Company

General Offices

DULUTH, MINN.

WAREHOUSES IN ALL CENTRAL STATES